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THE INFLUENCE OF SELECTED ENVIRONMENTAL FACTORS UPON OVIPOSITION OF EMPOASCA FABAE (HARRIS) (CICADELLIDAE, HOMOPTERA)

by

Lawrence Eugene O'Keeffe

A Dissertation Submitted to the

Graduate Faculty in Partial Fulfillment of

The Requirements for the Degree of

DOCTOR OF PHILOSOPHY

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Approved:

Signatures have been redacted for privacy.

Iowa State University
Of Science and Technology
Ames, Iowa

1965

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INTRODUCTION

The natural interactions of insects and their preferred host plants are the result of a long and continuing evolutionary process. Various mechanisms of defense against phytophagous insects have evolved in many plant groups. Conversely, mechanisms for the selection and utilization of specific plant types for food or other needs have evolved among insects. If these interactions are to be defined, the chemical and physical qualities of the plant which serve as stimuli to insects, and the insect's inherent perceptive ability and behavioral responses to such stimuli must be analyzed at several organizational levels.

Elements in the interactions of *Empoasca fabae* (Harris), a polyphagous insect, and its host plants have been noted from time to time but the regulatory principles governing the interactions have not been sharply defined. It is toward a clearer definition of the interactions of *E. fabae* and its tuber-bearing *Solanum* hosts that the investigations reported in this dissertation were directed. The research objectives were: (1) to identify and measure the influence of important variables affecting the oviposition response under laboratory conditions. (2) to establish standard laboratory conditions necessary for reproducibility in measuring the oviposition response of *E. fabae*. (3) to measure oviposition on *Solanum* and *Phaseolus* species from various origins under laboratory conditions.

The literature reviewed in the next paragraphs further introduces the area of investigation. Differential numbers of *E. fabae* eggs received by acceptable hosts was inferred from counts of nymphs on genetically different potato selections and species (Sleesman and Bushnell, 1937; Sleesman, 1940; Sleesman and Stevenson, 1941), among bean selections and species (Wolfenbarger and Sleesman, 1961a, 1961b) and among leguminous hosts (Poos and Smith, 1931; Poos and Johnson, 1936; Davis and Wilson, 1953; and Newton and Barnes, 1965). Recently Carlson and Hibbs (1962) and Miller and Hibbs (1963) reported direct counts of eggs among genetically different Solanum clones and on individual potato plant parts. The number of leafhopper eggs received by individual clones in a replicated field planting ranged more than sixfold in uniform samples of apical leaflets (Carlson and Hibbs, 1962). Differences in the relative number of eggs received by individual clones were statistically confirmed in sampling subsequent field plantings (Miller, 1962). In addition, the distribution of immigrating adults (mostly females) among these clones aggregated in large numbers on certain ones and in small numbers on others indicating the independent selectivity of individuals. On individual potato plants E. fabae females consistently selected oviposition sites on terminal leaflets in the mid-portion of the plant avoiding basal and terminal leaves and leaf rachises. These investigations clearly reflect selective responses of E. fabae females to plants which present different characteristics.

DeWilde, Slooff and Bongers (1960) demonstrated that oviposition preference of the Colorado potato beetle is not merely a consequence of feeding preference. However, Dethier (1953) mentioned that many species choose oviposition sites on the basis of taste sampling. Dethier reduced the questions about host preference to two primary ones: (1) what is the genetic basis and evolutionary history of specific host selectivity, (2) how is the preference implemented or in other words how does it operate.

Recent reviews on host-plant selection and related aspects have been presented by Nuorteva (1952), Dethier (1953), Kennedy (1953), Lipke and Fraenkel (1956), Thorsteinson (1960), and Beck (1965). These papers probe deeply into the intricacies of a complex natural phenomenon. Disagreement on certain points is apparent, e.g. the influence of "token stimuli" versus "nutrient stimuli" in feeding behavior. However, accord is reached on the importance of chemotactic stimuli residing in the host plant and the insect responses to them. Although visual stimuli have been reported as an important part in orientation to the plant by many insects, Thorsteinson (1960, p. 200) stated, "Shape, size and color are too variable and lack the identifiable uniqueness required to explain the obvious discriminatory power of insects. On the other hand, the chemical constitution of plants comprises an almost inexhaustible variety of substances". It is presumed by these reviewers that plant stimuli operating especially in regulating feeding behavior are largely chemical in nature and act upon the insect's olfactory and gustatory senses. In gustation tactile stimuli are associated with chemoreception and their influence cannot easily be separated from the chemical component. The influence of tactile stimuli on oviposition behavior has been recorded. For example the diamondback moth, <u>Plutella maculipennis</u>, oviposits more freely on a roughened polyethylene surface than on a smooth substrate of the same material (Gupta and Thorsteinson, 1960).

Beck (1965) described the behavioral events involved in oviposition.

The first component is that of "recognition" and "orientation" to the host plant followed by an orientation to rather specific oviposition sites (see Miller and Hibbs, 1963), and finally the oviposition. Each of the innate behavioral components is displayed only in response to proper combinations of extrinsic releasing stimuli from the plant and intrinsic response threshold levels in the insect. Plant characteristics may prevent or curtail egg-laying by failing to provide the appropriate releasing stimuli for one or more of the behavioral components or by emitting stimuli that directly suppress oviposition behavior. Behavioral components of feeding parallel those of oviposition. Steps in feeding include host-plant recognition and orientation, initiation of feeding by biting or piercing, maintenance of ingestion, and finally, cessation of feeding. The plant must contain the necessary feeding stimulants and lack repellants or inhibitors if the feeding response is to occur.

MATERIALS AND METHODS

Empoasca fabae[1] were reared continuously on broad bean, Vicia faba L., in the Zoology and Entomology Insectary greenhouse at Iowa State University. The greenhouse culture was initiated with leafhoppers collected from a natural infestation on potatoes in the Iowa State University Insectary garden. All of the leafhoppers included in this investigation came from the greenhouse culture. Voucher specimens have been submitted to the Iowa State University insect collection for preservation.

With a few exceptions noted in the description of individual experiments, all female leafhoppers were handled methodically prior to subjection of test conditions. The standard preconditioning follows: 500 to a 1000 fifth-instar nymphs were collected with an aspirator from V. faba plants in the culture cages. The nymphs were placed in a saran-screen-covered cage, 24-inch x 24-inch x 20-inch, on excised foliage-bearing stems of V. faba of which the cut ends were immersed in 3% sucrose solution. The insects were not disturbed for 8 to 10 days while adult emergence and mating took place. Fresh bean stems and foliage were added as required for food. At the end of the period adults were removed individually with an aspirator. Males were discarded. Females were placed in individual square plastic snap-box cages, 1.2-inch x 1.2-inch, with a circular one-quarter inch opening. A feeding and oviposition substrate was provided by an excised V. faba stem 3 to 4 inches long extending into the cage

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[1]Specimens of a composite sample from the culture were identified as Empoasca fabae (Harris) by H. B. Cunningham, Illinois Natural History Survey, Urbana, Illinois.

approximately an inch, the opposite end immersed in a 3% sucrose solution contained in a florist's waterpick. The stem was wrapped with absorbent cotton to form a protective juncture between cage and waterpick and to prevent the insect's escape. In addition a tuft of cotton was placed in the exposed hollow stem tip to prevent the female from becoming trapped within.

The number of eggs laid by individual females was observed at 3-day intervals. Stems and solutions were replaced with those freshly prepared at the end of each interval. The typical experimental sequence included a pretest period, two to five reaction periods, and in instances where the oviposition substrate was other than a V. faba stem, a recovery period. The pretest period was used to assay the egg production level of each individual. Non-layers were discarded. Laying females were randomly allocated to various test groups. The experimental conditions were randomly assigned to the selected groups prior to the first reaction period. The procedures used up to the time of assigning groups to experimental conditions are referred to as standard preconditioning in the remainder of the text. An individual's egg-laying record was separately tabulated for an entire experimental sequence.

Individual eggs were counted at the end of each period. The exposed stem portion was excised at the cotton juncture, longitudinally split on one side, and threaded on a 28-gauge tinned-steel wire to which a labeled wooden tag was attached. Twenty to 30 stem samples could be handled with each wooden tag. Two such tags and samples were transferred to a 5-quart pyrex casserole containing an actively boiling solution of lactophenol (one part each of lactic acid, phenol, distilled water and two parts glycerol, Carlson and Hibbs, 1962). The stems were immersed, and held beneath the surface by a weighted galvanized 1-inch x 1-inch mesh screen for four minutes. The stems were removed and placed in cold lactophenol solution until eggs were counted. Cleared stems to be examined for eggs were placed in a 3/8-inch depth of lactophenol in an inverted lid of the pyrex dish. Egg outlines were readily visible in the plant tissue with the aid of transmitted light and 10 or 20 magnifications.

Oviposition rates for *E. fabae* females used in this investigation are reported as eggs per day per female for individual periods. Only those females surviving all reaction periods are included in the means of the data analyzed by statistical methods. In exploratory experiments in which the data were not subjected to analysis of variance the means represent egg production of all females tested in individual reaction periods including females that died and their production in preceding periods. Oviposition rates (i.e., eggs per day per female) were calculated from the following formula:

$$\text{Oviposition rate} = \frac{\text{Number of eggs} \times \dfrac{\text{24 hours}}{\text{Hours elapsed between periods}}}{\text{Number of females}}$$

A converted walk-in cooler provided constant environmental conditions during tests. Light was supplied by two fixtures each of which included four 6-foot 140-watt cool white fluorescent lamps and four 50-watt incandescent lamps mounted in a white adjustable reflector. Each pair of fluorescent lamps was controlled by a time switch. Air in the chamber was recirculated over a cooling coil by a single 12-inch fan and over the light fixtures by two 6-inch fans. A water-cooled condensor provided refrigeration. No attempt was made to control humidity. Constant-temperature cabinets placed in the converted walk-in cooler were used to provide conditions of darkness. A Freas Model 70 constant-temperature cabinet was used as a reaction chamber. Temperature measurements were taken within plastic snap-box cages located adjacent to cages containing females. Temperatures were recorded during individual experiments with a Yellow Springs Instrument Model 43 tele-thermometer and thermistor probes.

Preliminary experiments

Females tested in groups   The number of eggs laid by groups of from 5 to 75 caged females randomly selected from culture cages were counted in evaluating the practicability of using caged groups in laboratory assays. Potted potato plants, potted bean plants, or excised bean foliage was exposed to the leafhopper groups for 3-, 4-, and 5-day periods. Photoperiod was programmed to 16 hours of light and 8 hours of darkness. The cages were located 15 inches from the lights. A temperature of 27°C was maintained in the controlled-environment chamber. A plastic vegetable crisper, 10.5-inch x 7.5-inch x 4.5-inch, modified by inserting screened top and bottom panels served for caging groups of 30 or more females. A plastic sandwich box, 4.8-inch x 4.8-inch x 1.5-inch, modified with screened top and bottom panels served as a cage for groups numbering less than 30.

Females tested individually   In three preliminary experiments, randomly selected females from culture cages were individually caged on *V. faba* stems. The influence of light, temperature, and oviposition substrate upon the number of eggs laid was measured.

The production of eggs by two groups of 20 individually caged females was measured on two ages of *V. faba* stem during two 5-day reaction periods. The leafhoppers were placed on stems from 49-day-old plants that were flowering profusely or on stems from 18-day-old plants not yet flowering. Photoperiod was programmed to 16 hours of light and 8 hours of darkness and a temperature of 26 $\pm$ 1°C was maintained.

The production of eggs by three groups of 12 individually caged females was measured on *V. faba* stem segments with one cut end of each stem immersed in one of three concentrations of sucrose during three 2-day reaction periods. The concentrations were, 1% and 4% sucrose solution, compared with water alone. Photoperiod was programmed to 16 hours of light and 8 hours of darkness. A temperature of 26 $\pm$ 1°C was maintained.

The number of eggs laid by 40 females during a 57-day period was measured under a variety of light, temperature, and substrate conditions. The reaction periods were of 4-day or 5-day duration. Light conditions included a period with 16 hours of light and 8 hours of darkness, and a period of continuous darkness alternated twice. Temperature was maintained at 25 $\pm$ 1°C for seven reaction periods and then increased by 2° increments to 31°C during three reaction periods. During the next two reaction periods it was dropped to 25°C and subsequently elevated to 31°C. Cut ends of *V. faba* stems were immersed in a 3% sucrose solution or in water alone. During three reaction periods one-half the individuals were held on stems subjected to one or the other of these sucrose-water treatments.

Biological factors

Individual lifetime egg production records of 61 mated and 13 unmated *E. fabae* females were compiled. Environmental conditions of light, temperature, and oviposition substrate were held constant while determining the degree of variability in egg production with time.

Temperatures were maintained at 25.5 $\pm$ 1°C. Lighting was operated at capacity over the cages on a 24-hour cycle of 16 hours of light and 8 hours of darkness. The distance from the fluorescent tubes to the cages was 18 inches during the first nine days. Because of a minor air circulation problem in the chamber during darkness the fluorescent tubes were raised to a level 32 inches above the cages for the remainder of the experiment.

Female source   Two hundred fifth-instar nymphs were collected during a 3-day period and individually caged on excised *V. faba* stems immersed in 3% sucrose solution, a method previously described for conditioning females. The leafhoppers were collected from two cages representing culture histories that were different. The controlled-environment-reared culture was started in early December from greenhouse cultures. It completed three generations under controlled conditions of light programmed for a 24-hour period with 16 hours of light and 8 hours of darkness, a temperature of 26 $\pm$ 1°C, and high relative humidity. The greenhouse-reared culture was started in July with field-collected adults and had been reared for 11 generations in the greenhouse under variable conditions. Reduced populations had been observed in the greenhouse culture during the winter months but numbers had remained stable in the controlled-environment culture.

Adults emerged from nymphs within four days of the last collection date. The age of adult females was counted from the time of shedding the final nymphal exuviae. Mean dates of adult emergence represent the first adult day, plus or minus one. The males were placed in a common cage. The females were given a fresh excised V. faba stem with one of the cut ends immersed in 3% sucrose solution. Stems and sucrose solutions were changed at the end of 3-day and 4-day reaction periods for the remainder of the experiment except during the mating period when this was shortened to two 60-hour periods. Cages containing individual females were replaced at the end of the mating period and at monthly intervals because of excessive fungal growth on honeydew secreted by leafhoppers in the cages.

Mating Two males, one reared individually and one collected at random in culture cages, were introduced into each cage containing a single female six days following the first adult day. There were 84 cages each containing two males and one female. An additional 14 females did not receive males. The cages containing males and females were observed for copulating pairs at intervals of 45 minutes or less for the next 72 hours except during 1 a.m. to 4:30 a.m. of the second and third days. During the mating period the leafhopper trios and the unmated females were held in a laboratory with large north-facing windows at room temperature. Light, temperature, and humidity conditions were not recorded. At the end of the mating period the males were removed, the stems were replaced with freshly prepared stems, and the females were transferred to the controlled-environment chamber.

Egg viability During one 4-day reaction period in the sixth week the viability of eggs from each female was observed. This required a delay in the usual procedure in egg counting. The exposed stems were held in an incubator at 29°C for 84 hours. Nymphs that hatched from eggs, eggs with eye-spot development, and eggs without development were recorded separately. Eggs showing eye-spot development were considered viable.

Physical environmental factors

Experiment a; light and dark Results of preliminary experiments suggested that light was not required for oviposition. The effect of light and dark on oviposition was investigated during eight reaction periods in the controlled-environment chamber previously described.

Two groups of 50 individually caged females were assigned to a light and a dark test condition following standard preconditioning. The lights were operated at capacity on a 24-hour cycle of 16 hours of light and 8 hours of darkness. The fluorescent tubes were located 32 inches above the cages. Continuous darkness was provided in a constant-temperature cabinet located in the controlled-environment chamber. The leafhoppers in all test conditions of darkness were exposed briefly to light every three days when stem and sucrose solutions were replaced.

Twenty-five of the 50 females from each test condition were selected randomly at the beginning of the experiment to be transferred to the converse test condition at the end of the third reaction period. One group of 25 individually caged females was transferred from the light to the dark test condition while the other was transferred from the dark to the light test condition. The experiment was carried on for an additional five reaction periods. Temperatures were maintained at 26 ± 1°C.

Experiments b and c; temperature The influence of temperature on oviposition was measured in two experiments. In the first, four groups of 37 individually caged females were randomly assigned to test conditions of 21, 25, 29, and 32°C. In the second, three groups of 34 individually caged females were randomly assigned to test conditions of 23, 25, and 27°C. Observations were made during four reaction periods for each experiment following standard preconditioning. The tests were conducted in continuous darkness in constant-temperature cabinets located in the controlled-environment chamber. Variance in temperature within the constant-temperature cabinets was less than ± 0.5°C. Changing of stems and sucrose solutions at the end of each reaction period was accomplished in a temperature-controlled transfer box so that test condition temperatures of the individuals were maintained throughout the experiments.

Oviposition and survival on selected substrates

Experiment a; sucrose Results of preliminary experiments suggested that an excised *V. faba* stem with one cut end immersed in sucrose solution was superior as an oviposition substrate to an excised *V. faba* stem held in water. The influence on oviposition of excised *V. faba* stems with cut ends immersed in one of four different sucrose solutions or in water alone was investigated during five reaction periods following standard preconditioning. The standard preconditioning period was altered by substituting water for the 3% sucrose solution usually supplied to *V. faba* stems. Five groups of 25 individually caged females were randomly assigned to test conditions of 3, 6, 9, and 12% sucrose solution and water alone. The tests were carried out in continuous darkness in constant-temperature cabinets maintained at 24 ± 0.5°C located in the controlled-environment chamber.

An experiment designed to measure the female's ability to select sucrose was conducted following the last reaction period and included females from the test conditions of water alone, 3 and 12% sucrose. Each female was offered a choice of two excised V. faba stems for oviposition or feeding; one in sucrose solution and one in water. Individuals coming from the water or 3% sucrose test condition had a choice of excised V. faba stems held in water or in 3% sucrose solution. Those from 12% sucrose had a choice of stems held in water or 12% sucrose solution. This experiment continued for two reaction periods at 24 ± 0.5°C in the dark.

Experiments b, c, d, e, and f; Solanum species The influence of plants of various Solanum species upon the egg-laying response and survival of E. fabae females was measured. Seventy-two accessions[2] representing 48 Solanum species of Central and South American origins were grown in the Insectary greenhouse from tubers and seed obtained from the United States Department of Agriculture Potato Introduction Station, Sturgeon Bay, Wisconsin. From two to four tubers and 10 to 15 seeds of each accession were planted.

The tubers of 54 accessions were "green-sprouted" by placing them

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[2]An introduced tuber-bearing Solanum stock or other plant introduction is identified by a Plant Introduction (P.I.) number and is propagated by the New Crops Research Branch of the United States Department of Agriculture (Ross and Rowe, 1965). Numbers following species names in this dissertation are P.I. numbers.

on a dry soil (two parts sand to one part Webster loam) in 2-inch peat pots in the greenhouse. The sprouts of most species formed green shoots and leaves within 10 days. Tubers exhibiting shoot and leaf development were buried in the soil of the pot, leaving the new shoot exposed. The plants were moved to a saran-screen-covered cage and watered from the pot base by means of a watering pan. Substantial root development and shoot elongation occurred in approximately 10 days. The plants were then potted in 4-inch clay pots and held in saran-screen-covered cages until sampled.

Seeds of 18 accessions were germinated in soil in 2-inch peat pots. Ten to 15 seeds of each accession were placed on the soil and covered with a layer of perlite which allowed light transmission to the seeds while keeping them moist. The seedling plants attained an approximate height of three inches in about 20 days. At this time they were potted in 4-inch clay pots and handled similarly to plants grown from tubers.

The plants were grown in the greenhouse under conditions of natural light and in a temperature range of 21 to 27°C during March, April, and May.

Only those accessions producing sufficient foliage and stem material to provide 30 uniform samples were tested. A sample consisted of excised foliage or stem with one cut end immersed in 3% sucrose solution or in water. The sample, contained within the square plastic snap-box cage (1.2-inch x 1.2-inch), provided a female with adequate food for three days. In some instances leaves were trimmed to fit within the cage.

Usually leaflets and a rachis were included from plants with an erect growth habit. Samples from plants with a prostrate growth habit included a leaf with petiole and a stem.

The influence of 38 of the 72 Solanum accessions upon E. fabae egg-laying and survival was investigated in five experiments. Each accession was tested with 15 preconditioned females during two reaction periods and a recovery period. Each reaction period included 15 excised samples from each accession with one cut end immersed, five in water and 10 in 3% sucrose solution. A preliminary experiment indicated that E. fabae survival was increased on excised Solanum tissues when 3% sucrose was added to the water in which they were held. The oviposition rate of 10 females receiving sucrose were observed during the pretest, reaction, and recovery periods for each accession. The five females tested on Solanum tissues with water as the liquid source were used only in assaying survival differences among the accessions although egg-laying records also were kept.

Experiment b consisted of seven groups of 10 or 15 individually caged females assigned at random to test conditions of five accessions (foliage and stem samples tested separately for one accession) and the V. faba control. Experiments c, d, e, and f each consisted of nine groups of 15 individually caged females assigned at random to test conditions of eight accessions and a V. faba control.

The experiments were carried out in continuous darkness in constant-temperature cabinets maintained at 24 $\pm$ 0.5°C.

Experiment g and h; Phaseolus species The influence of plants of three Phaseolus species upon the egg-laying response and survival of E. fabae females was measured. Twenty accessions were grown in the

Insectary greenhouse from seeds obtained from the United States Department of Agriculture, Western Regional Plant Introduction Station, Pullman, Washington.

Six seeds of each accession were germinated in soil (two parts sand to one part Webster loam) in 2-inch pots contained in saran-screen-covered cages. When two to three seedling plants in each pot attained a height of approximately four inches they were potted in 4-inch clay pots and grown in the screened cages. Two plantings of each accession were made.

The plants were grown in the greenhouse under conditions of natural light and in a temperature range of 21 to 27°C during April, May and June.

Only those accessions producing sufficient foliage to provide 30 uniform samples were tested. A sample consisted of excised foliage of a single leaflet and rachis or petiole with one cut end immersed in 3% sucrose solution or water. The leaflet sample required trimming of the outer edges to fit within the square snap-box cage previously described. The sample was of adequate size to provide a female with food for three days.

The influence of 14 of the 20 Phaseolus accessions upon E. fabae egg-laying and survival was investigated in two experiments. Each accession was tested with 15 preconditioned females during two reaction periods and a recovery period. Each reaction period included 15 excised samples from each accession with one cut end immersed, five in water and 10 in 3% sucrose. The oviposition rate of the 10 females receiving sucrose was observed. The five females receiving water were utilized only in assaying survival.

Experiment g consisted of nine groups of 15 individually caged females assigned at random to test conditions of eight accessions and the V. faba control. Experiment h consisted of seven groups of 15 individually caged females assigned at random to test conditions of six accessions and the *V. faba* control.

The experiments were carried out in continuous darkness in constant-temperature cabinets maintained at 24 $\pm$ 0.5°C.

Experiment i; survival on S. chacoense Differences between the survival of *E. fabae* on excised *S. chacoense* stems held in water and the survival of those held on stems in 3% sucrose solution were investigated further. Stems of accession 133-085 were used. Females in cages supplied with water were offered 3% sucrose in an agar plate covered with filter paper and situated on the side of each cage. The agar-sucrose plate contained 2 x 10^{-5} grams per milliliter of rhodamine B. This vital dye served as a color indicator of imbibition by the leafhopper. A duplicate set of test conditions with *V. faba* stems served as a control.

Eight groups of 10 individually caged females were assigned to four test conditions each of excised *S. chacoense* and *V. faba* stems. Each set of 10 stems had one cut end of each stem immersed in water or in 3% sucrose solution. Two sets of stems, one with water and one with 3% sucrose were caged with cages containing the sucrose-agar plate.

Observations were made during two reaction periods and a recovery period following standard preconditioning. The tests were conducted in continuous darkness in constant-temperature cabinets maintained at 24 $\pm$ 0.5°C.

RESULTS

Preliminary experiments

Females tested in groups The number of eggs laid by groups of from 5 to 75 females are reported in Appendix Table 6. Groups including equal numbers of females tested under similar conditions varied in egg production from cage to cage and from group to group. Such variation would require prohibitively large numbers of individuals in several replications if reproducible results were to be obtained.

Females tested individually Results of several experiments for assaying individual female egg production and recording variation among females are summarized in Appendix Table 7. Large numbers of non-laying females were recorded among these groups. Most of the oviposition rates were considerably below those reported for *E. fabae* in the literature. For example, one group of 83 females contained only 20 that laid eggs during a 4-day period and the oviposition rate was only 0.4 eggs per day. The need to standardize the source of females and also to evaluate individual egg production prior to subjecting the females to test conditions became apparent.

The number of eggs laid per day on excised *V. faba* stems differing in age by 31 days are reported in Table 1. The small differences in oviposition rates between females on plant stems of differing ages were not considered significant. However, in all experiments using *V. faba* stems attempts were made to select uniform plant material from individual flats of *V. faba* similar in age, size, and growing conditions.

Table 1. Number of *E. fabae* eggs laid per day on excised *V. faba* stems during five-day reaction periods

Stem	Number of females	Reaction period 1	Reaction period 2
49 days old	20	1.69	1.69
18 days old	20	2.01	1.84

The number of eggs received by *V. faba* stem segments held in water or in water to which sucrose was added are reported in Table 2. A comparison of the number of eggs recorded on stems in each test condition suggested that the addition of sucrose enhanced *E. fabae* egg-laying. The number of eggs laid by the 12 individually caged females on stems held in water remained near 0.5 eggs per day while those on stems in 4% sucrose increased to 2.2 eggs per day.

Table 2. Number of *E. fabae* eggs laid per day on excised *V. faba* stems during two-day reaction periods

Stem in	Number of females	Reaction period 1	Reaction period 2	Reaction period 3
Water	12	.54	.50	.40
1% sucrose solution	12	.50	.88	1.42
4% sucrose solution	12	.79	.91	2.21

The number of eggs laid by 40 females during 57 days under a variety of light, temperature, and oviposition substrates are reported in Appendix Table 8. The several test conditions overlapping each other and applied to the same females for such a long period produced such a complexity of data that the influence of any individual factor upon oviposition could not be measured effectively. However, the experiment indicated two observable trends. When females were placed in continuous darkness they produced eggs at levels comparable to those observed under light. In addition the increase or decrease of several degrees centigrade correspondingly increased or decreased the oviposition rate.

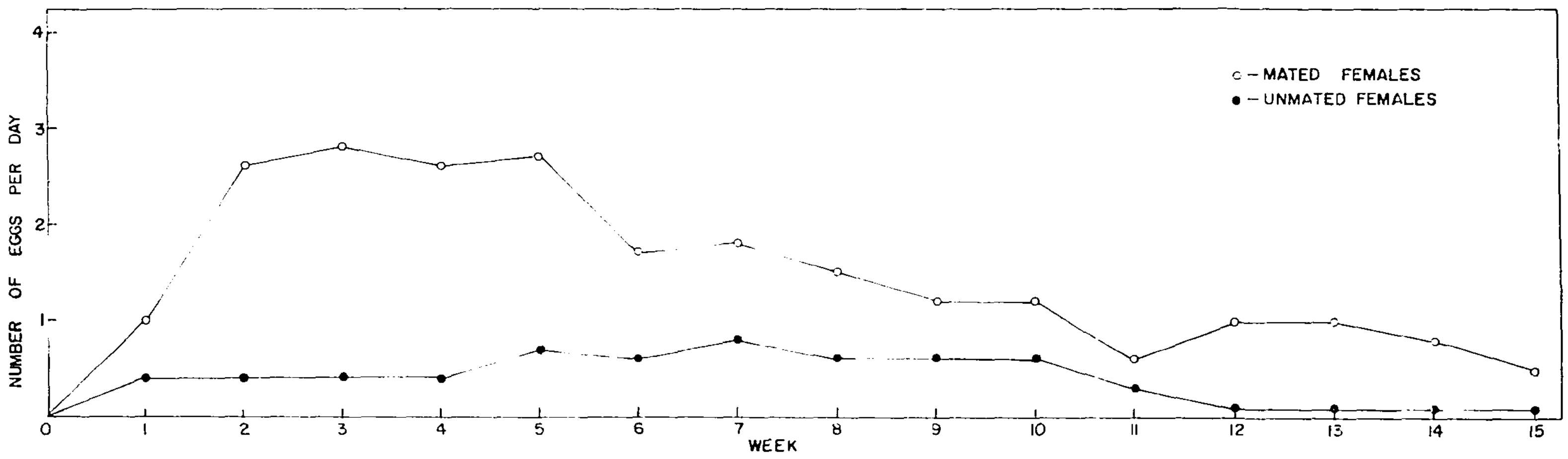
Biological factors

Individual lifetime egg production records of 61 mated and 13 unmated *E. fabae* females are reported in Appendix Tables 9 and 10. The female age at mating in the mated group is given.

Sixty-one of 84 females exposed to males during three days were observed in copulation. The 23 not observed in copulation were discarded. The approximate average in copulation time was 69 minutes. Matings occurred primarily during the early morning or late afternoon hours of the first and second days after exposure to males. A few matings were recorded during the morning of the third day.

The mean number of eggs produced by the mated and unmated females (two egg counts combined to form a weekly mean) are illustrated in Figure 1. Mated females reached peak production of near 2.7 eggs per day by the second week and maintained this level through the fifth week. During the remainder of the experiment a gradual decline in egg production was observed.

Figure 1. Number of *E. fabae* eggs laid per day on excised *V. faba* stems by unmated females and females of known mating dates


○ – MATED FEMALES
● – UNMATED FEMALES
NUMBER OF EGGS PER DAY
0 1 2 3 4
WEEK
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Sixty-one per cent of the eggs were laid by the mated females during the first five weeks. Unmated females laid eggs at much reduced rates with a peak production of near 0.7 eggs per day from the fifth to the tenth week.

The number of eggs produced during the first six weeks of production by the two groups of mated females previously reared under dissimilar conditions were nearly alike. The mean number of eggs produced during the second to the sixth week by females from the controlled-environment culture were respectively 2.6, 2.9, 2.5, 2.7, and 1.7 eggs per day. The mean number of eggs produced by those from the greenhouse culture were 2.6, 2.6, 2.6, 2.6, and 1.6 eggs per day respectively. Although differences were not observed, general culture procedures included the blending of adults from several cages at the beginning of each generation in an individual cage. This insured that any single cage within the culture had more than one source of adults to start the next generation.

Considerable variation was observed in egg production from period to period, in the total number of eggs produced, and in the longevity of individual mated females. The average mated female produced a mean number of 1.8 eggs per day during a mean longevity of 63 days. Three females observed in copulation produced no eggs although one lived for 77 days. Eight females laid fewer than one egg per day. Twenty-eight of the remaining 50 females laid two or more eggs per day during their lifetime.

Nearly all mated females attained their maximum egg production levels shortly after copulation. To determine the approximate time interval between copulation and maximum production individual matings were observed and recorded from the time both sexes were released into a common cage. The egg-laying records of the 61 matings were grouped according to six successive 12-hour periods in which copulation occurred. The number of eggs laid by each group was plotted for two reaction periods during the time males were present, and for a third period when males had been removed (Figure 2). The groups that copulated in the first and second 12-hour periods reached their maximum oviposition of three eggs per day during the second reaction period. The group that copulated during the third 12-hour period attained a rate of two eggs per day within the same reaction period. The number of eggs laid by groups that copulated during the fourth and sixth 12-hour periods were much lower in this reaction period than the maximum attained by females that had copulated earlier. The data suggested that most females reached maximum oviposition within two or three days after copulation. However, there were exceptions, six of the 61 mated individuals under observation did not begin laying at levels above two eggs per day until the fourth or fifth week following copulation.

A life span of up to 12 weeks was recorded for mated females. Unmated females lived longer with three of the original 13 still alive when the experiment was terminated. The per cent survival of the mated and unmated female groups during the 15 weeks under observation is illustrated in Figure 3. The 50% survival time of the mated group occurred during the ninth week and in the unmated group during the twelfth week. The mortality rate of the mated group increased after the seventh week. The average length of life of the mated and unmated females was 63 days and 89 days respectively.

Figure 2. Number of *E. fabae* eggs laid per day on excised *V. faba* stems during the mating period

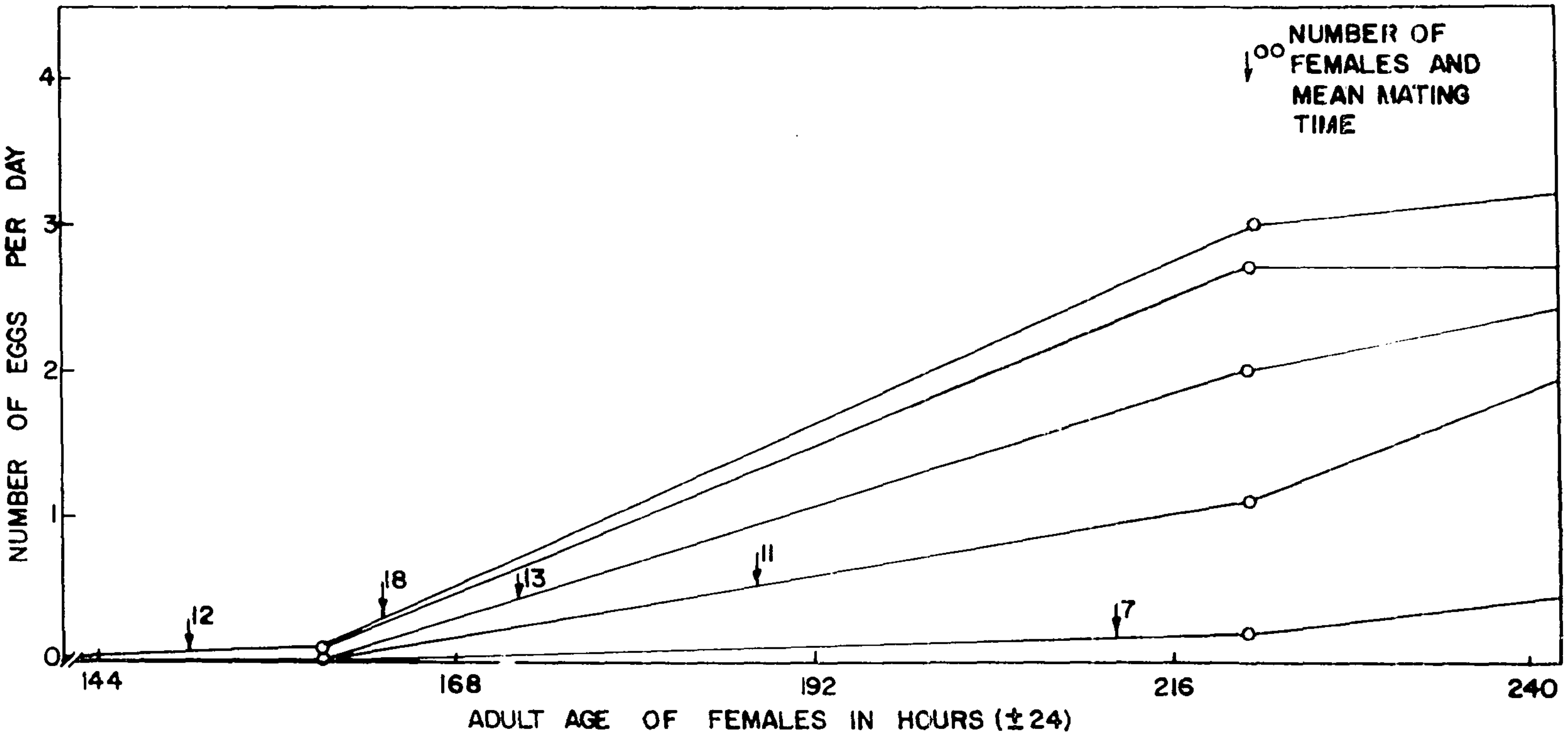
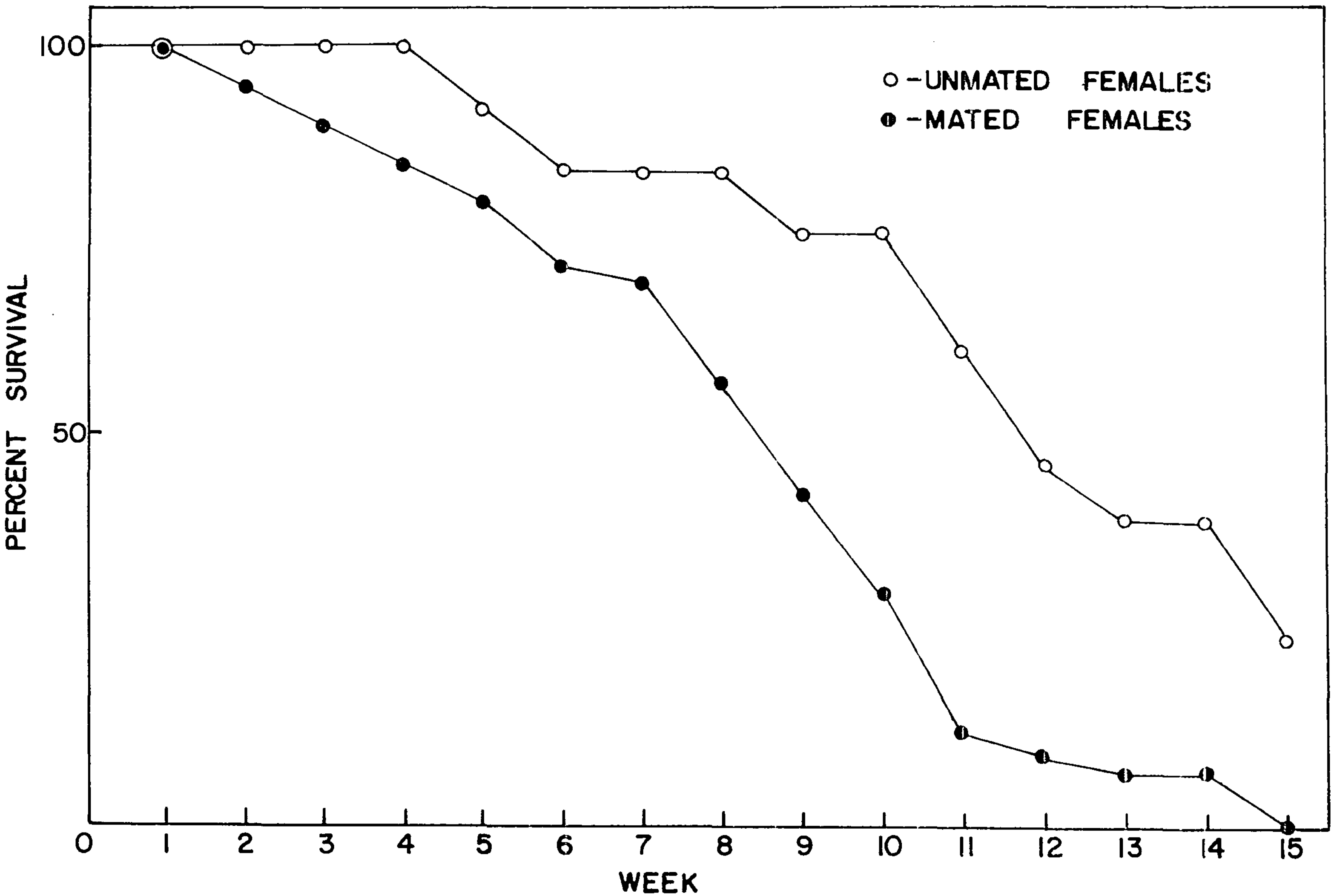

NUMBER OF FEMALES AND MEAN MATING TIME
100
18
13
11
12
7
NUMBER OF EGGS PER DAY
0
1
2
3
4
144
168
192
216
240
ADULT AGE OF FEMALES IN HOURS (± 24)

Figure 3. Survival of unmated and mated *E. fabae* females


○ -UNMATED FEMALES
◐ -MATED FEMALES
PERCENT SURVIVAL
100
50
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
WEEK

The viability of eggs from each laying female was observed during the sixth week. Of the 49 mated females still alive, 41 laid viable eggs and two did not. Six mated females did not lay eggs during the observation period. Nine of the 12 unmated females still alive laid eggs. None of the eggs produced by the unmated group were viable.

Physical environmental factors

Experiment a; light and dark The number of *E. fabae* eggs laid on excised *V. faba* stems under conditions of 16 hours of light alternated with 8 hours of darkness and on stems under continuous darkness are reported in Appendix Table 11. During the first three reaction periods, females in continuous darkness averaged 2.9 eggs per day which differed significantly from the 2.1 eggs per day produced by females receiving 16 hours of light (Appendix Table 12).

During the next five reaction periods those females remaining in continuous darkness averaged 3.2 eggs per day while those continuing to receive 16 hours of light averaged 2.1 eggs per day. The female group transferred from the light to the dark test condition averaged 2.6 eggs per day while those transferred from the dark to the light test condition averaged 2.8 eggs per day. A statistical analysis of the data recorded in these five reaction periods indicated no significant difference in number of eggs laid by the four groups (Appendix Table 13). However, the difference in mean number of eggs between those produced in the dark and those from the light test condition was 1.1 eggs per day per female in the last five reaction periods compared with a difference of 0.9 eggs per day recorded in the first three reaction periods where statistical significance at the 1% level of probability was recorded. In addition, the group transferred from dark to light decreased in egg production below the group continuing in dark while the converse group increased in egg production above the group continuing in light (Figure 4).

Experiments b and c; temperature The number of *E. fabae* eggs laid on excised *V. faba* stems in response to temperatures of 21, 25, 29, and 32°C in experiment b and among temperatures of 23, 25, and 27°C in experiment c are reported in Appendix Tables 14 and 15. In experiment b females laid significantly more eggs at 32°C than they laid at each of the three other temperatures. The number of eggs laid at 29°C was significantly greater than the number recorded for 25 or 21°C (Appendix Table 16). In experiment c there were no significant differences in the number of eggs laid at temperatures of 23, 25, and 27°C (Appendix Table 17).

Different numbers of eggs were laid in response to the different temperatures of experiment b during the four reaction periods (Appendix Table 16 and Figure 5). A nearly straight line relationship with increasing temperature resulting in increased egg production was observed during the first two reaction periods. Differences in number of eggs produced during the third and fourth reaction periods were not as pronounced. High egg production was evident at 32°C during the third period but not during the fourth. Differences in egg production among 21, 25, and 29°C were not apparent in reaction period three. During reaction period four only small differences in number of eggs recorded for the two high and two low temperatures were observed.

Survival of the 37 females exposed to each temperature during the four reaction periods of experiment b differed considerably. Only 19

Figure 4. Number of *E. fabae* eggs laid per day on excised *V. faba* stems during three-day reaction periods following standard preconditioning

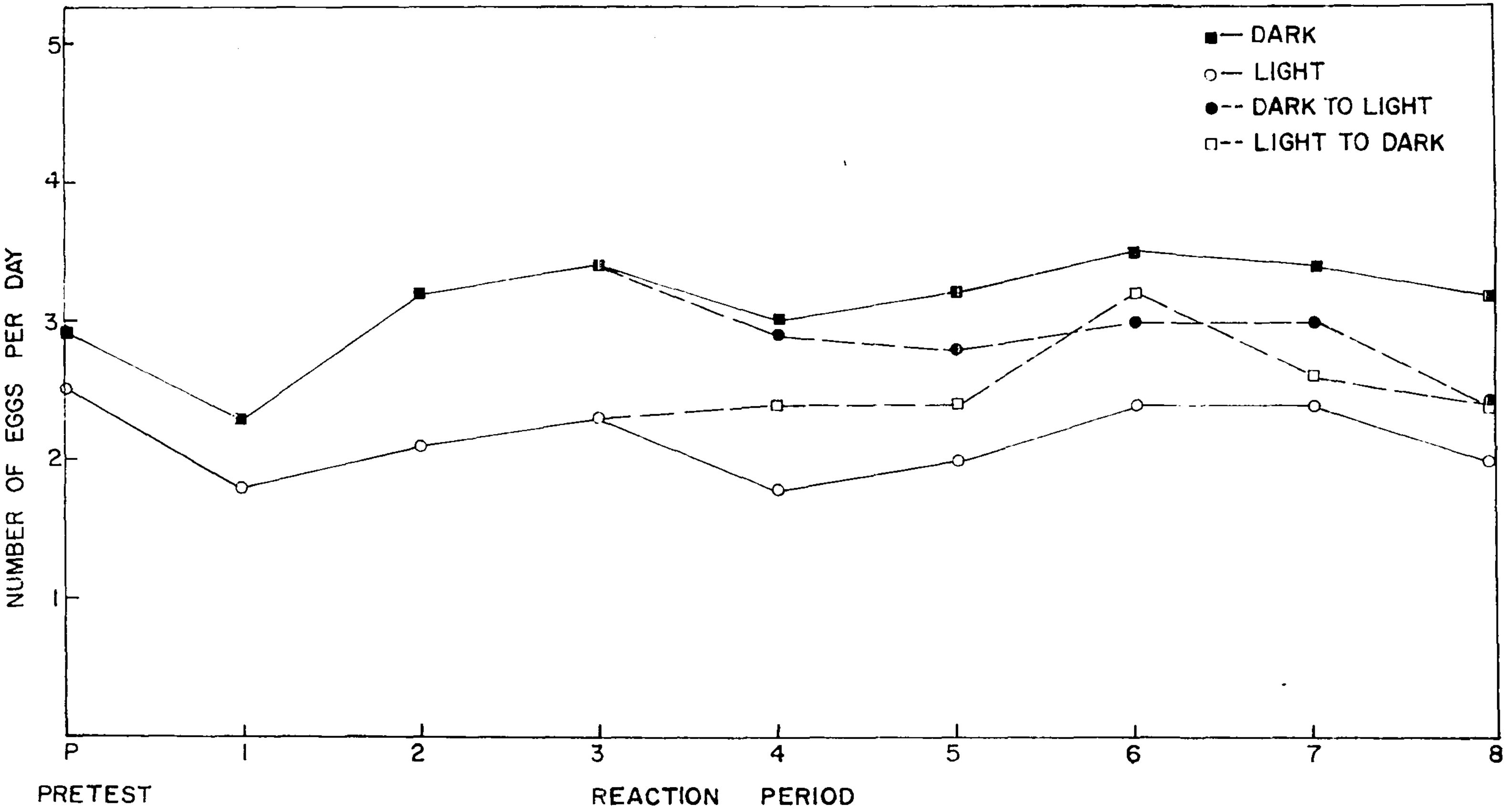
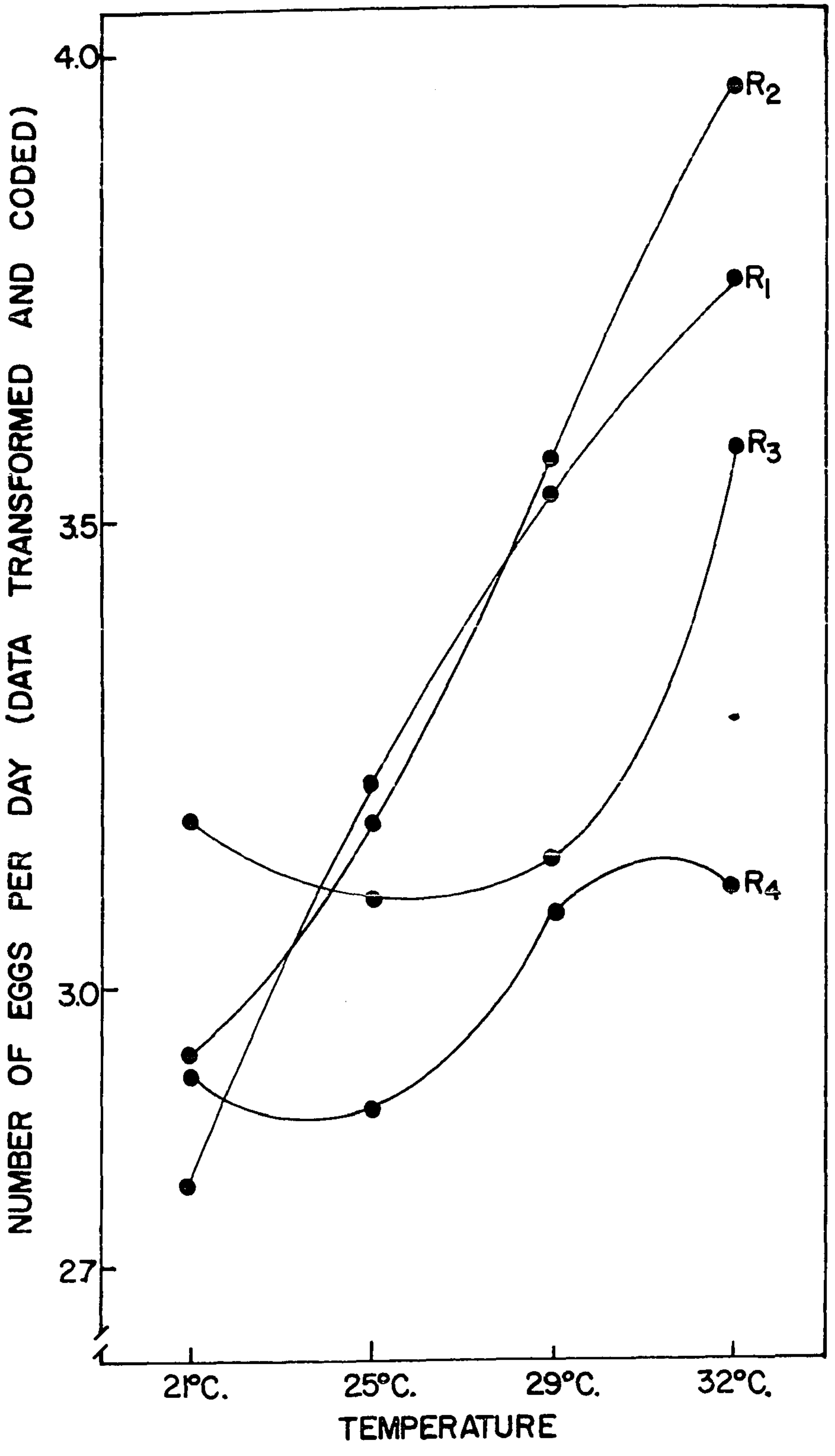

■— DARK
○— LIGHT
●-- DARK TO LIGHT
□-- LIGHT TO DARK
NUMBER OF EGGS PER DAY
1
2
3
4
5
P
1
2
3
4
5
6
7
8
PRETEST
REACTION PERIOD

Figure 5. Number of *E. fabae* eggs laid per day on excised *V. faba* stems during three-day reaction periods (R) following standard preconditioning


NUMBER OF EGGS PER DAY (DATA TRANSFORMED AND CODED)
4.0
3.5
3.0
2.7
R_2
R_1
R_3
R_4
21°C.
25°C.
29°C.
32°C.
TEMPERATURE

females survived at 32°C. At 29°C 24 survived. In comparison 36 females survived at 21°C and 31 survived at 25°C.

In experiment c, temperature did not influence survival of females. Of the original 34 females, 32, 28, and 30 females survived at temperatures of 23, 25, and 27°C respectively.

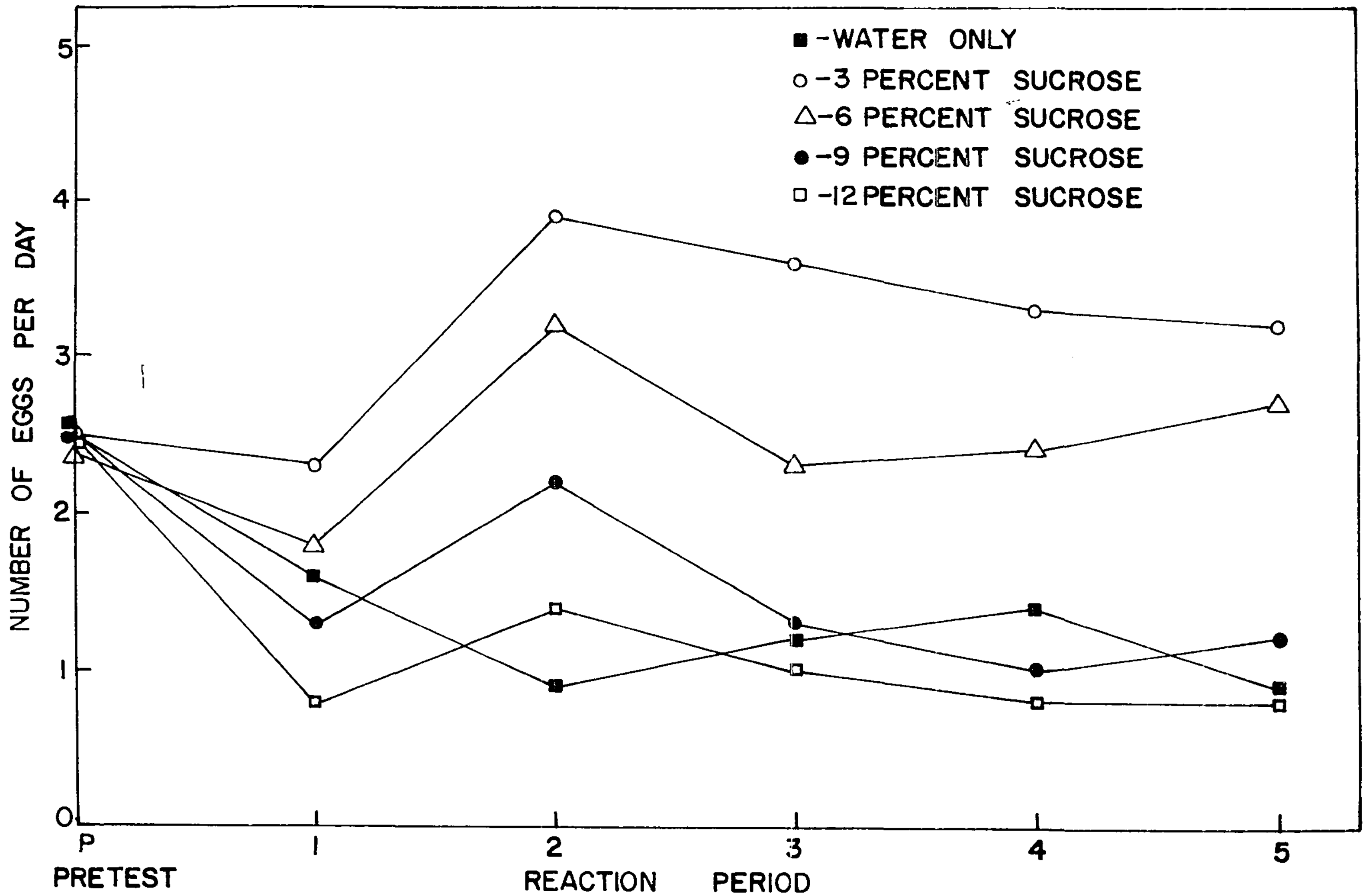
Oviposition and survival on selected substrates

Experiment a; sucrose The number of *E. fabae* eggs laid on excised *V. faba* stems held in 3, 6, 9, and 12% sucrose solution and water alone are reported in Appendix Table 18. The number of eggs laid on stems was significantly influenced by the sucrose concentration or water alone in which the stems were held (Appendix Table 19 and Figure 6).

Females on stems held in 3% sucrose solution produced the largest number of eggs of any test condition in each reaction period. A mean production of 3.3 eggs per day was recorded for the five periods. The greatest number of eggs laid on stems held in 3% sucrose was recorded during the second period and continued at a slightly reduced rate during the remaining three periods. The least number of eggs was recorded during the first period. The number of eggs laid on stems held in 6% sucrose solution was similar to, but less than the number recorded on stems in 3% sucrose. A mean production of 2.5 eggs per day was recorded on stems held in 6% sucrose during the five reaction periods.

Females on stems held in 9 or 12% sucrose solution or water alone produced a much smaller number of eggs than was recorded on stems held in 3 or 6% sucrose solution. Mean production during the five reaction periods for 9 and 12% sucrose solution or water alone were 1.4, 1.0, and 1.2 eggs per day respectively.

Figure 6. Number of *E. fabae* eggs laid per day on excised *V. faba* stems during three-day reaction periods following standard preconditioning



■ -WATER ONLY
○ -3 PERCENT SUCROSE
△-6 PERCENT SUCROSE
● -9 PERCENT SUCROSE
□ -12 PERCENT SUCROSE
NUMBER OF EGGS PER DAY
0
1
2
3
4
5
P
PRETEST
1
2
3
4
5
REACTION PERIOD

The per cent of eggs laid on stems held in sucrose solution or water when females had opportunity for a choice between the two substrates are presented in Table 3. The data are inconclusive in demonstrating the female's ability to perceive sucrose in the oviposition substrate. Females from the water test condition laid 69% of their eggs in stems held in 3% sucrose during the first reaction period but only 45% in the second period. Females from the 3% sucrose test condition tended to select stems held in water as oviposition substrates. Females from the 12% sucrose test condition showed no selection during the first reaction period and a positive selection for stems held in water during the second period. Egg production by the females from the water test condition increased from an average of 1.2 eggs per day to 2.5 eggs per day when stems held in 3% sucrose were introduced into their environment during the 6-day period.

Experiments b, c, d, e, and f; *Solanum* species The number of eggs laid and the survival of individually caged *E. fabae* females on 38 *Solanum* accessions is presented in Appendix Table 20. Oviposition and survival were notably influenced by various accessions. Three classes of oviposition response were arbitrarily established. The classes, based on the degree of suppression of the number of eggs per day per female received during two reaction periods, include: (1) egg-laying suppressed, (2) intermediate, and (3) egg-laying not suppressed. Each accession was placed in one of these classes on the basis of the number of eggs it received per day (Table 4). Two survival classes were established. If 10 or more females remained alive during the two reaction periods, survival was classed as

Table 3. Selective oviposition by *E. fabae* on excised *V. faba* stems held in water or sucrose solutions

Preconditioned group	Number of females	Eggs per day	Reaction period 1			Reaction period 2		
			water % eggs	3% sucrose % eggs	Eggs per day	water % eggs	3% sucrose % eggs	Eggs per day
From water	20	1.30	31	69	1.27	55	45	2.54
From 3% sucrose solution	24	3.28	61	39	3.00	56	44	2.60
			water	12% sucrose		water	12% sucrose	
From 12% sucrose solution	16	.96	50	50	1.36	79	21	1.86

Table 4. Class of *Solanum* accessions grouped upon the basis of whether the number of eggs received was suppressed or not and upon the survival of *E. fabae* females during two reaction periods

Survival of females	Egg-laying suppressed	Intermediate	Egg-laying not suppressed
Low	*S. brachycarpum* (251-721) *S. chacoense* (133-124) (197-760.7) (230-581.11) *S. polyadenium* (230-463) (275-237) (275-238)	*S. capsicibaccatum* *S. cardiophyllum* *S. chacoense* (133-085) (189-219.8) (133-619) *S. demissum* (160-220.2) *S. spegazzinii*	*S. phureja* *S. stenophyllidium*
High	*S. chacoense* (stem only) (133-085) *S. demissum* (160-221.2) *S. hougasii* *S. kurtzianum* *S. maglia* *S. polytrichon*	*S. brachycarpum* (275-180.5) *S. demissum* (161-149.5) (161-181.10) (161-725.5) *S. jamesii* *S. pampasense* *S. simplicifolium* *S. tarijense*	*S. acaule* *S. acroscopicum* *S. chiquidenum* *S. curtilobum* *S. fendleri* *S. gourlayi* *S. megistacrolobum* *S. sucrense* *S. vernei*

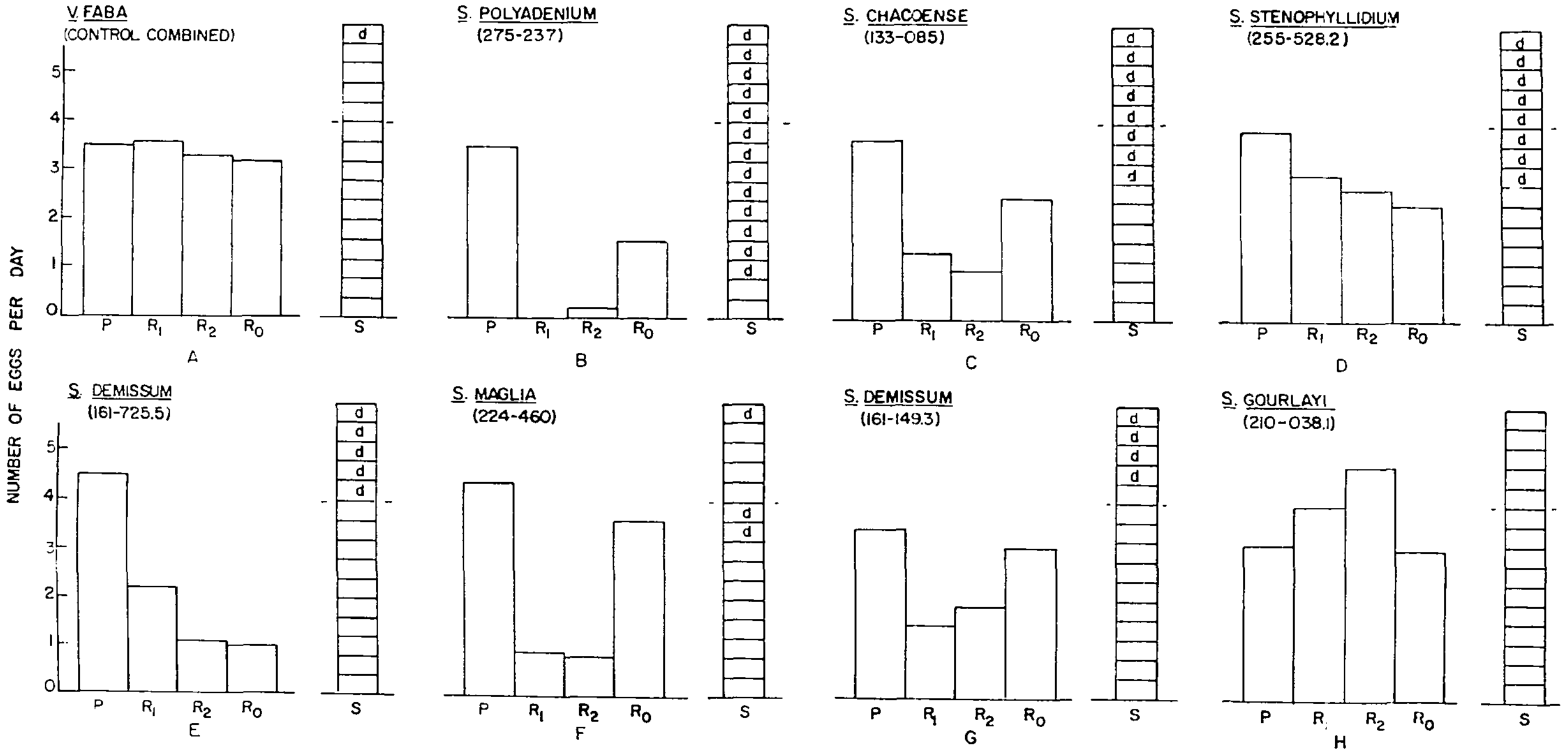
high. If nine or fewer survived the two periods it was classed as low. Each accession was placed in one or the other of these subclasses (Table 4). Representatives of each class are graphically presented in Figure 7.

Variation in the number of eggs laid by _E. fabae_ among the 26 _Solanum_ species ranged from nearly total suppression by _S. polyadenium_ to no suppression by _S. gourlayi_. Eight species, some represented by more than one accession, were classed as suppressing egg-laying. Ten species, some represented by more than one accession including some with accessions represented in the above class exhibited an intermediate egg-laying response. Eleven species did not measurably influence the oviposition response of _E. fabae_ and did not differ from the appropriate _V. faba_ control.

Variation in oviposition response was observed among accessions of those species tested in multiple. The three _S. polyadenium_ accessions were an exception, exhibiting nearly total suppression of the egg-laying response. Three accessions of _S. chacoense_ and the stem tissue of a fourth, 133-085, along with one accession each of _S. demissum_ and _S. brachycarpum_ were in the class designated as suppressing egg-laying. However, representatives of these three species were included in the class exhibiting intermediate suppression of egg-laying. These were three accessions of _S. chacoense_ including foliage of 133-085 (tested separately from stem), three accessions of _S. demissum_, and one accession of _S. brachycarpum_. No accession of the species listing accessions in the two classes showing oviposition suppression were represented in the non-

Figure 7. Number of *E. fabae* eggs laid per day and females surviving on representatives of excised *Solanum* species during three-day reaction periods (R_1, R_2) following standard preconditioning (P) and preceding recovery (R_0) on excised *V. faba* stem

A, Control; B, C, D, three classes of egg laying with low survival; E, no recovery; F, G. H, three classes of egg laying with high survival; d, died during the experiment


NUMBER OF EGGS PER DAY
V. FABA
(CONTROL COMBINED)
S. POLYADENIUM
(275-237)
S. CHACOENSE
(133-085)
S. STENOPHYLLIDIUM
(255-528.2)
S. DEMISSUM
(161-725.5)
S. MAGLIA
(224-460)
S. DEMISSUM
(161-149.3)
S. GOURLAYI
(210-038.1)
0
1
2
3
4
5
P
R1
R2
R0
S
d
A
B
C
D
E
F
G
H

suppression class.

When returned to *V. faba* stems, females tested on 27 *Solanum* accessions returned to a production of more than one egg per day per female in all but two accessions of *S. chacoense*. On a single accession of *S. demissum* egg production recovered to a rate of slightly more than one (Figure 7). Females from nine additional accessions exhibited recoveries to rates of less than two eggs per day, however, seven of these also exhibited low survival thus decreasing the chance of recording an accurate recovery rate. On 15 accessions there were oviposition recoveries to rates of two eggs or more per day, comparing favorably with the *V. faba* controls.

Marked differences in *E. fabae* survival were observed among the *Solanum* species investigated. Low survival on nine species was recorded. This group included the three accessions of *S. polyadenium* and the six accessions of *S. chacoense* (excluding stem tissue of 133-085 tested separately). The same species subclass, with the two exceptions of *S. phureja* and *S. stenophyllidium*, were recorded as suppressing *E. fabae* egg-laying as well. *Solanum brachycarpum* had an accession representative in each survival category. The remaining 18 species were classified in the high survival group. Included in this group were four of the five *S. demissum* accessions tested. The species accessions in the later category were nearly equally represented in the three classes of oviposition response based on suppression.

Testing *E. fabae* survival on excised *Solanum* tissues with a liquid source of only water and testing *E. fabae* oviposition responses on excised

Solanum tissues with a liquid source including 3% sucrose was effective. Only 37% of the 195 preconditioned females tested on excised Solanum samples with a water source survived the two 3-day reaction periods. Eighty-three per cent of the 375 preconditioned females tested on excised Solanum samples with a liquid source providing sucrose survived the two 3-day reaction periods. In comparison, 75% of the preconditioned females survived on excised V. faba stems in the five controls wherein water alone was used and 100% when sucrose was added. The average per cent survivals recorded on Solanum accessions classified according to their effect upon egg production and upon female survival are presented in Table 5.

Table 5. Per cent of females surviving on groups of Solanum accessions classed according to the number of eggs received and the number of females surviving on them

	Egg-laying suppressed		Intermediate		Egg-laying not suppressed	
Survival	Water	Sucrose	Water	Sucrose	Water	Sucrose
Low	20	59	17	71	0	80
High	60	92	30	97	64	95

Species were placed in the low survival category as a result of mortality occurring not only on samples held in water but also on those containing sucrose. In the high survival category there was but little mortality when sucrose was added.

Experiment g and h; Phaseolus species The number of eggs laid and survival of individually caged *E. fabae* females on 14 *Phaseolus* accessions representing three species are presented in Appendix Table 21. Of the 14 accessions tested, three were reported to be susceptible, six were considered to be resistant, and the remaining five were classed as having a low order of resistance to *E. fabae* infestation in the field (Wolfenbarger and Sleesman, 1961a, 1961b).

In these experiments three accessions exhibited suppression of egg-laying, six exhibited an intermediate suppression and five did not measurably influence the oviposition response compared with the appropriate *V. faba* controls. Oviposition rates comparable to the *V. faba* controls were recorded for females on the three accessions classed as susceptible by Wolfenbarger and Sleesman. Of the six accessions classed as resistant by Wolfenbarger and Sleesman only one suppressed egg-laying. An oviposition rate of 3.6 eggs per day, surpassing the *V. faba* control, was recorded for females on one accession of this group. The remaining four exhibited an intermediate suppression. Two of the five accessions classed as having a low order of resistance in the field were found to suppress oviposition, two exhibited an intermediate suppression, and one was comparable to the *V. faba* control.

High survival of females was recorded on *Phaseolus* species in these experiments. Only one of the 14 *Phaseolus* accessions tested would have been placed in the low survival class of the *Solanum* series. The females tested on *Phaseolus* accessions returned to egg production levels comparable to those of the *V. faba* controls during the recovery period.

Experiment i; survival on S. chacoense   Survival and egg production of individually caged females on S. chacoense stems (133-085) and a V. faba control held in water or in 3% sucrose solution with or without an alternate source of sucrose are reported in Appendix Table 22. Eight of the 10 females caged on S. chacoense stems held in water without a source of sucrose died during the two 3-day reaction periods. All 30 females caged on S. chacoense stems with their cut ends immersed in a sucrose solution or in cages with plant stems in water and sucrose supplied in an agar plate, survived the two periods. The mortality recorded in the V. faba controls compared favorably with that recorded for the controls of the Solanum and Phaseolus species experiments. All females having access to the agar-sucrose plate containing the rhodamine B dye turned red during the 6-day period indicating that the females had imbibed fluids from the agar-sucrose plates.

The number of eggs laid by females on S. chacoense in the four test conditions: stems held in water (with and without an agar plate) and stems held in sucrose (with and without an agar plate) were 0.1, 0.2, 0.1, and 0.2 eggs per day per female respectively. Results on the same four V. faba control conditions were 2.0, 1.6, 2.8, and 2.8 respectively. The influence of excised stems of S. chacoense (133-085) on oviposition was nearly the same as that recorded in Solanum species experiment b.

DISCUSSION

The establishment of standard laboratory conditions required for reproducibility is requisite to testing oviposition responses to variables associated with insect-plant interactions. With E. fabae it was necessary to adjust for intrinsic sources of variation in oviposition among individual females and to identify and measure the influence range of important variables in the external physical and biological environment. Studies of the influence of biological substrates upon oviposition were initiated only after a specified set of conditions was established which would provide reproducible oviposition responses.

Preliminary experiments

The measurement of egg production by groups or individual females of E. fabae in preliminary experiments adequately demonstrated the need for defining and controlling the sources of variation. Some records of individual oviposition rates (inferred from counts of nymphs) are available in early biological studies of Fenton and Hartzell (1923), DeLong (1928; 1938), and others. DeLong (1938) observed leafhoppers under variable conditions of a screened insectary and recorded rates of 2.8, 2.3, and 3.0 eggs per female per day for E. fabae during a three year period. DeLong (1928, p. 187) stated, "Observations for rather long periods upon a large number of females indicate that there is a wide variation in the number of eggs deposited by individuals. The great majority show an average of two or three eggs per day".

Biological factors

Investigations of potential sources of egg production variation intrinsic to the female included observations on the source of the female within the leafhopper culture, mating in relation to oviposition, length of preoviposition periods, and age of females in relation to maximal oviposition rates. The possibility of innate variation in egg production capacity among females of the *E. fabae* culture was recognized. The latter variation was accommodated by sampling methods and data analysis techniques.

Differences in egg production were not observed between the two groups of females reared under dissimilar conditions which in effect presented two distinct sources of females from the culture. Therefore nymph collections from various culture cages at a specific time for an individual experiment were considered to yield a uniform source of females.

Differences were apparent in the number of eggs produced by mated and unmated females. High egg production was associated only with mated individuals laying viable eggs. The unmated females laid at low rates and the eggs laid were nonviable. High levels of egg production were reached by mated groups within two days following copulation. Mating normally occured within 48 hours after emergence and one mating was reported as sufficient for fertilization of eggs during the entire life span of a female (DeLong, 1938). The use of mated females was considered requisite to selecting test insects for studying *E. fabae* oviposition responses.

Oviposition rates of *E. fabae* females changed with increasing age of the individuals. Maximum production levels following mating were reached by the second week and were maintained through the fifth week. Females continued to oviposit until near the end of their lives but the oviposition rate of the group gradually declined. Similar results have been recorded by Harries and Douglass (1948) for the beet leafhopper, *Circulifer tenellus*. Individual life spans of up to 15 weeks were recorded for mated females; however, mortality rates of this group increased rapidly following the seventh week. It was found preferable to test *E. fabae* oviposition responses during the period when most females were at maximum egg production and when mortality was minimal. The period began approximately three to four days following adult emergence and mating and continued for 25 to 30 days.

Physical environmental factors

Light, temperature, and humidity are well-known physical factors influencing oviposition and other physiological and behavioral processes of terrestrial insects (Richardson, 1925). In establishing standard laboratory conditions required for reproducible oviposition responses it was necessary to identify and measure the influence range of the important variables. The influence of these variables could then be stabilized in studies of other factors.

A preliminary experiment indicated that *E. fabae* would oviposit in continuous darkness as well as during a period of 16 hours of light and 8 hours of darkness. Results of a refined experiment demonstrated conclusively that oviposition rates recorded in continuous darkness were higher, or at least equal, to rates recorded for a similar group in 16 hours of light and 8 hours of darkness. It was considered desirable to eliminate light quality, intensity, and duration as variables in assaying the oviposition response of E. fabae under laboratory conditions. Harries and Douglass (1948) reported that egg-laying by the beet leafhopper, Circulifer tenellus, was unaffected by quality or intensity of light. However, a photoperiod of 16 hours compared with one of 9 hours has been recently reported to enhance E. fabae oviposition rates (Kieckhefer and Medler, 1964).

Harries (1939) has stated that the influence of temperature on insect oviposition is limited by definite temperature extremes within which oviposition rates are accelerated to a maximum and then are retarded by increasingly higher temperatures.

The number of eggs laid by E. fabae females exposed to constant temperatures of 29 or 32°C in experiment b was significantly greater than the number recorded for the lower temperatures. Egg-laying was considerably increased by the high temperatures during the first and second reaction periods but this level of production diminished considerably by the fourth period. Differences were not observed in number of eggs produced by females exposed to constant temperatures of 21 and 25°C in experiment b or by females exposed to constant temperatures of 23, 25, and 27°C in experiment c.

Considerable female mortality was associated with maximum oviposition at the higher temperatures. This mortality was not observed at the lower temperatures. On the basis of differences in survival at the high and low temperatures and uniform oviposition among temperatures in the lower range, 24°C was selected as an optimum temperature at which to test E. fabae oviposition in remaining experiments.

DeLong (1938) reported that E. fabae egg-laying seemed to occur normally over a rather wide range of temperatures and that high temperatures of 32°C or slightly above did not prevent or arrest egg-laying. He did report that sudden drops in temperatures for periods of several hours or days inhibited oviposition. Kieckhefer and Medler (1964) suggested that the optimum number of E. fabae nymphs developed from eggs laid by females held at a temperature of 23.9°C, that 21.1°C was the next best temperature, and that oviposition at temperatures of 18.3, 26.7, and 29.4°C produced considerably fewer nymphs. They found that no nymphs emerged from plants held during oviposition periods in temperatures of 15.6 or 32.2°C.

Oviposition and survival on selected substrates

Investigations of E. fabae responses to oviposition substrates included an evaluation of excised V. faba stems altered by the addition of selected sucrose concentrations. Further, a search was made for the influence of plant characteristics associated with genetically different host types of Solanum and Phaseolus species.

The increased number of eggs laid by individual females exposed to excised V. faba stems held in sucrose solutions was observed in a preliminary experiment. Consequently, all experiments included the addition of sucrose to the substrates in the expectation that if sucrose were supplied, differences in the numbers of eggs received by selected substrates would be due to factors other than variation in sucrose content.

It was later demonstrated that a 3% sucrose solution supplied to excised *V. faba* stems instigated a maximum oviposition response in comparison to higher concentrations or to controls without sucrose. The maximum response to 3% sucrose occurred during the second 3-days of exposure while the minimum response occurred during the first 3-days of exposure. The increased response raises the question of whether the nutrition of the insect or some releasing mechanism triggered by sucrose level of the substrate is involved. Results of the selection experiment were inconclusive in determining whether or not preconditioned females could perceive optimum sucrose concentrations.

Responses of increased oviposition rates attributable to the stimulation afforded by sucrose in the diets of other insects have been observed (Blake, 1961; Doucette and Eide, 1955; Rasso and Fraenkel, 1954). The concentrations of sucrose occurring in *Phaseolus* spp. have been identified as important phagostimulants for the Mexican bean beetle, *Epilachna varivestis*, and sucrose is suggested to play the role of an arrestant in host-plant preferences of this insect (Augustine et al., 1964). Hibbs, Dahlman, and Rice (1964) reported that total sugar concentrations in potato foliage was elevated by leafhopper infestation and that the greatest sugar concentration occurred in the midrange leaves, an area previously identified as preferred oviposition sites of *E. fabae*. They suggested that feeding preference for foliage with higher sugar concentrations may regulate choice of oviposition sites on accepted host plants. The relationship of sucrose to *E. fabae* oviposition or to host-plant selection should be a fruitful area to investigate further.

Empoasca fabae oviposition responses to various Solanum and Phaseolus species and accessions were sharply differentiated. Variation among species and among accessions within species ranged from nearly total suppression of the egg-laying response to no observed effect in comparison with V. faba controls. The results of these experiments demonstrated the existence of plant characteristics that prevented or curtailed egg-laying in E. fabae. The task of identifying the plant component involved in the response and of defining the precise insect behavior that is influenced remains.

Differences were observed in E. fabae survival among the species and accessions tested especially in two Solanum species which included a number of accessions. These were S. polyadenium and S. chacoense. Possible plant mechanisms involved in the low survival included plant factors that interfered with normal feeding behavior of the insect thus resulting in death through starvation, or the existence of natural toxic factors which resulted in increased mortality, or both. Low leafhopper survival was associated with excised tissue held in water in nearly all Solanum accessions in contrast to high survival on excised tissue held in sucrose solutions. High survival was observed for all but one of the Phaseolus accessions.

Results of experiment i indicated that increased survival on S. chacoense stems with sucrose made available in an agar-sucrose plate (not via the excised S. chacoense stems) was due to the influence of sucrose imbibed from the agar plate. With sucrose available in the agar plate, insects survived while those without sucrose died. However, the egg-laying record on S. chacoense stems did not establish whether the insects had visited the plant material or not.

The plant characteristics responsible for the suppression of oviposition probably were not the same ones that were responsible for the low survival observed in this series of experiments. High rates of survival were recorded for some accessions which actively suppressed egg-laying. On the other hand, low survival rates were recorded for some accessions from which high egg-laying records were obtained.

The influence of Solanum and Phaseolus accessions in actively suppressing egg-laying and reducing survival of E. fabae under laboratory conditions has not previously been reported. Four of the species tested in this study, S. chacoense, S. demissum, S. jamesii and S. polyadenium, were reported to support relatively few numbers of nymphs in Slessman's (1940) comparative study of nymphs developing on 12 Solanum species under field infestation. He reported that S. polyadenium was highly resistant if not immune to leafhopper attack and that S. chacoense was nearly as resistant. The data obtained in the present study suggest that the field resistance observed for S. polyadenium and S. chacoense reflect both a suppression of the number of eggs laid and also the improbability of leafhopper survival upon the plants. Former studies of field resistance in potato to E. fabae which included egg or nymph counts utilized only clones available in specific breeding programs or commercial varieties. Commercial varieties do not exhibit wide differences in leafhopper populations. The clones in breeding programs where variation in E. fabae response has been recorded may or may not be readily available for intensive study. It is anticipated that other investigators studying the interactions of *E. fabae* and its tuber-bearing *Solanum* hosts will find the record of *E. fabae* oviposition and survival responses to *Solanum* species of value.

Selection of the *Phaseolus* accessions that were tested in the laboratory was based on the results of field counts of nymphs reported by Wolfenbarger and Sleesman (1961a, 1961b). A comparison of my laboratory observations with those reported from field observations of individual accessions indicated the following trends. The three accessions reported to have high nymph counts in the field received large numbers of eggs under laboratory conditions. With two exceptions, those reported to be resistant in the field were found to suppress egg-laying in the laboratory. The maximum suppression of egg-laying observed among *Phaseolus* accessions was not as great as recorded for many of the *Solanum* accessions and all but three of the *Phaseolus* accessions would have been placed in the intermediate suppression class established for the *Solanum* series. In Wolfenbarger and Slessman's field studies the opportunity for choice of oviposition sites among several accessions may have influenced the data but in the present study the laboratory methods used excluded the opportunity for choice.

Utilizing excised plant tissue as the feeding and ovipositing substrate in developing laboratory methods for measuring the variation in *E. fabae* oviposition was necessary because suitable synthetic substrates have not been developed. The questionable biochemical stability of excised tissue is an obstacle to interpretation of data which might involve the influence of the insect's nutrition, behavior, or toxicity of the substrate.

In a review of the biochemical processes of excised leaves, Bonner (1950) reported that leaves change rapidly from photosynthetic to respiratory processes when excised and placed in the dark. Proteins are hydrolyzed and amides and amino acids accumulate in cuttings placed in either light or dark. Changes in carbohydrates and organic acids also take place. Respiration of the leaf proceeds primarily at the expense of carbohydrates during the early periods following excision (approximately three days), but amino acids and organic acids eventually become involved as respiratory substances. In addition to biochemical changes, Beck (1956) pointed out that excised plant tissues held near room temperature will undergo changes in water and hydrogen-ion relationships and are subject to microbial attacks.

It was recognized that the attribution of differences in oviposition rates to characteristics of excised plant tissue, e. g. in comparing Solanum or Phaseolus plant substrates, or to sucrose concentrations offered via excised V. faba stems, are valid only if the frequency of renewing excised tissues and sucrose solutions has adequately circumvented disrupting biochemical degradation. Such biochemical changes would influence responses involving nutrition, acceptance- or rejection-behavior, or intoxication of the insect. Excised plant material has been successfully used in studies of other phytophagous insects. For example, Maltais (1959) demonstrated enhanced growth of the pea aphid, Acyrthosiphon pisum, on plant cuttings in different organic nutrient solutions and Gupta and Thorsteinson (1960) utilized plant cuttings in a study of the sensory regulation of oviposition of the diamondback moth, *Plutella maculipennis*.

In observing the importance and influence various factors have on *E. fabae* oviposition it is well to keep in mind that feeding response may be intimately involved.

SUMMARY

Oviposition-site selection by *Empoasca fabae* among accepted hosts has been clearly evidenced in past work. Eventual explanations of the principles regulating these interactions will be defined at the physiological level of organization and will be based on the chemical and physical properties of the organisms involved. My investigations have been directed towards a clearer definition of the interactions.

The identification and measurement of the effects of important external physical and biological factors influencing oviposition was undertaken. Standard laboratory conditions necessary to obtain reproducible egg production were established. Under standardized conditions, selected *Solanum* and *Phaseolus* species were assayed for their acceptability as substrates to ovipositing *E. fabae*.

A summary of the investigations follows:

1. Light quality, intensity, and duration were eliminated as environmental variables during test periods when it was found that egg production proceeded at full capacity without light.

2. Maximum oviposition was recorded at 29 and 32°C for short periods but these temperatures were associated with excessive female mortality. Oviposition rates were approximately the same at temperatures of 21, 23, 25, and 27°C. A temperature of 24°C was selected as optimum for testing oviposition responses.

3. Maximum oviposition by mated females was obtained during approximately 30 days following adult emergence.

4. Preconditioning of females to reduce variation in egg production

during tests required the collection of fifth-instar nymphs, holding them under uniform conditions during emergence to adult forms, mating, preoviposition, and initial egg production. Only females producing at known rates were included in tests.

5. The addition of 3% sucrose solution to excised plant stems instigated maximum oviposition and increased survival on certain test plants.

6. Egg production by preconditioned females was suppressed below appropriate controls on samples of the following Solanum accessions: S. brachycarpum 251-721; S. chacoense 133-124, 197-760.7, and 230-581.11; S. polyadenium 230-463, 275-237, and 275-238; S. chacoense 133-085 (stem only); S. demissum 160-221.2; S. hougasii 161-740.4; S. kurtzianum 175-434.1; S. maglia 224-460; and S. polytrichon 184-768.1. Survival of females on the first seven accessions was low; on the last six, high.

Egg production by preconditioned females was not suppressed on samples of the following Solanum accessions: S. phureja 225-673.4, S. stenophyllidium 255-528.2; S. acaule 210-032.1; S. acroscopicum 230-495.4; S. chiquidenum 275-269.1; S. curtilobum 225-651.4; S. fendleri 275-162; S. gourlayi 210-038.1; S. megistacrolobum 210-034.1; S. sucrense 230-465.6; and S. vernei 230-468.2. Survival of females on the first two accessions was low; on the last nine, high.

Egg production by preconditioned females was intermediate on samples of the following Solanum accessions: S. capsicibaccatum 205-560.1; S. cardiophyllum 184-766; S. chacoense 133-085, 189-219.8, and 133-619; S. demissum 160-220.2; S. spegazzinii 218-218.7; S. brachycarpum

275-180.5; *S. demissum* 161-149.3, 161-181.10, and 161-725.5; *S. jamesii* 275-264.1; *S. pampasense* 275-274.10; *S. simplicifolium* 218-224.2; and *S. tarijense* 230-466.3. Survival of females on the first seven accessions was low; on the last eight, high.

7. Egg production by preconditioned females was suppressed below appropriate controls samples of the following *Phaseolus* accessions: *P. lunatus* 194-314; and *P. vulgaris* 174-901, and 136-741.

Egg production by preconditioned females was not suppressed on samples of the following Phaseolus accessions: *P. aureus* 217-959, and 164-889; and *P. vulgaris* 206-975, 209-467, and 169-733.

Egg production by preconditioned females was intermediate on samples of the following *Phaseolus* accessions: *P. aureus* 219-699, and 207-504; *P. lunatus* 209-051, and 195-340; and *P. vulgaris* 151-014, and 169-718.

Survival of females was high on all accessions except *P. vulgaris* 151-014.

It is anticipated that the establishment of standard conditions for reproducible oviposition responses, and the recording of *E. fabae* oviposition and survival responses to *Solanum* and *Phaseolus* species will contribute substantially to further studies of *E. fabae* - *Solanum* interactions.

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APPENDIX

Table 6. Number of eggs laid by groups of *E. fabae* females in preliminary test situations

Oviposition substrate	Number females per cage	Days exposed	Number of eggs observed in cage 1	2	3	4
Bean potted	10	3	11	1	32	-
	10	3	13	9	61	10
	50	4	5	50	4	1
	50	3	21	35	30	2
	50	5	21	8	90	47
	30	4	12	10	12	21
	35	5	4	0	0	1
Bean excised	5-20	3	2	7	10	7
	10-25	5	15	94	-	-
Potato potted	50	4	49	56	56	26
	75	4	25	1	68	0

Table 7. Number of *E. fabae* eggs laid per day on excised *V. faba* stems in preliminary test situations

	Reaction period								
	1			2			3		
	Number of females	Number laying	Eggs per day	Number of females	Number laying	Eggs per day	Number of females	Number laying	Eggs per day
	14	14	3.18	10	9	2.30	10	9	1.2
	36	13	.35	34	17	.65	33	17	.79
	83	20	.37	-	-	-	-	-	-
	29	18	.57	26	21	.85	23	22	1.76
	34	19	.54	32	20	1.28	15	14	3.08
	85	58	.83	81	69	1.14	48	41	1.41
	50	1	.00	44	18	.25	42	22	.24
	37	29	1.07	37	29	.86	36	26	.61
Total	368	172		264	183		207	151	

Table 8. Number of *E. fabae* eggs laid on excised *V. faba* stems in preliminary test situations

Reaction period											
Five-day					Four-day			Five-day			
Light					Dark					Light	Dark
Sucrose		Sucrose and Water			Water	Sucrose					
25°C.							27°C.	29°C.	31°C.	25°C.	31°C.
13	13	15	12	6	5	10	12	14	10[d]		
4	5	2	1	1	3	5	8	5[d]			
10	11	9	20	13	9	22	20	25	20	11	19
4	2	3	0	3	5	7	6	6	10	0	0
4	2	5	2	1	3	9	6	11	25	11	3
4	4	6	6	4	10	8	11	12	21	5	19
9	12	8	6	3[d]							
4	5	5	7	4	8	10	7	6	8	2	1
7	11	10	14	2	13	20	8[d]				
6	2	3	4	1	3	5	6	12	8	1	17
7	16	18	8	11	5	15[d]					
4	7	4	3	2	1	4	5	10	12	4	0
3	14	16	14	7	3	5	9	8	17	14	24
6	13	6	1[d]								
9	10	10	8	6[d]							
3	3	2	3	5	9	15	16	9	22	10	15
3	2	3	3	2	2	5	6	3	10	4	6
17	13	8	12	16	4	18	5	4	6	3	15
4	16	22	14	11	11	0	0[d]				

[d]Died during this reaction period; this symbol will appear as such in following tables.

Table 8 (Continued).

	Reaction period											
	Five-day					Four-day			Five-day			
	Light						Dark				Light	Dark
	Sucrose	Sucrose and Water				Water	Sucrose					
		25°C.						27°C.	29°C.	31°C.	25°C.	31°C.
	8	11	7	3	4	4	6	3	6	8	4	3
	11	9	14	16	10	8	7	6	5	6	8	1[d]
	3	4	2	5	3	8	5	6	4	23	11[d]	
	6	3	7	7	6	9	10	8	17	26	3	6
	17	8	11	9	10	10	14	10	5	14	0	5
	7	3	16	8	0[d]							
	5	7	4[d]									
	17	17	6	8	8[d]							
	4	2	2	2	5	8	10	13	26	23	13	20
	5	10	9	12	11	9	9	4	8[d]			
	3	13	12	17	10	11	8	12	15	18	6	21
	15	19	10	12	9	5	12	11	15	20	7	7
	3	9	6	8	8	11	11	6	10	8	12	3
	8	10	15	6	6	6[d]						
	10	15	14	8	6	0[d]						
	16	18	8[d]									
	13	19	13	11	8	8	10	9	8	17[d]		
	6	12	14	9	9	6	5	4	4[d]			
	2	8	2	4	6	3	11	4	16	14	3	6
	7	9	8	9	9[d]							
	6	3	0	0	0	7	2	3	1	6	7	8
Total	293	370	335	292	226	207	278	224	265	352	139	199
Mean	1.46	1.85	1.68	1.54	1.22	1.62	2.32	1.93	1.96	2.93	1.26	1.90

Table 9. Number of *E. fabae* eggs laid on excised *V. faba* stems by females of known mating dates

Female age at mating (hrs.)	Female days alive (±4)	Total eggs	Week of egg production														
			1[a]	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Controlled-environment reared																	
172	18	8	0	8[d]													
172	21	20	7	10	3[d]												
172	28	74	11	33	30	0[d]											
172	32	73	7	18	21	27[d]											
188	32	78	5	29	26	18[d]											
172	35	87	2	18	28	33	6[d]										
188	43	108	12	13	39	18	17	9[d]									
172	43	100	8	34	17	25	14	2[d]									
236	46	67	1	36	21	2	5	2[d]									
163	49	95	0	6	17	31	28	11	2[d]								
172	56	136	9	24	38	20	8	6	18	3[d]							
172	56	147	7	30	33	30	22	12	11	2[d]							
150	60	78	9	23	13	8	11	11	0	3[d]							
236	63	100	2	8	9	29	18	16	9	6	3[d]						
212	63	84	0	7	14	21	12	2	16	12	0[d]						
163	67	132	13	26	29	15	21	11	4	8	5[d]						

[a]Represents first five days after exposure to males.

Table 9 (Continued).

Female age at mating (hrs.)	Female days alive (±4)	Total eggs	Week of egg production 1[a]	2	3	4	5	6	7	8	9	10	11	12	13	14	15
150	67	145	10	21	23	15	31	11	8	14	12[d]						
150	67	159	12	28	28	19	20	20	22	9	1[d]						
150	74	141	5	16	13	15	18	16	22	10	13	13[d]					
163	74	152	14	20	28	18	19	20	24	4	4	1[d]					
212	74	183	1	7	11	37	27	34	26	24	9	7[d]					
188	77	127	1	22	22	19	23	10	1	11	9	8	1[d]				
163	77	154	7	17	25	27	19	9	11	12	16	11	0[d]				
163	81	172	13	26	28	14	30	14	18	10	9	10	0[d]				
212	81	67	0	1	7	13	7	7	9	9	12	2	0[d]				
163	81	166	11	22	24	18	18	13	18	17	17	6	2[d]				
150	81	162	2	20	21	10	34	14	11	16	18	14	2[d]				
212	88	143	0	2	6	12	29	18	21	23	12	20	0	0[d]			
150	88	175	7	29	30	16	19	11	16	17	10	12	4	4[d]			
150	112	216	0	1	1	0	18	18	29	31	35	32	6	19	17	6	3[d]
150	116	94	8	3	5	2	5	7	4	5	3	6	10	7	5	14	10[d]
Subtotal	1950	3643	184	558	610	512	489	304	300	246	188	142	25	30	22	20	13
Mean	62.9	117.5	1.19	2.57	2.91	2.52	2.69	1.74	1.95	1.68	1.49	1.56	.36	1.07	1.57	1.43	.93

Table 9 (Continued).

Female age at mating (hrs.)	Female days alive (±4)	Total eggs	Week of egg production 1[a]	2	3	4	5	6	7	8	9	10	11	12	13	14	15
								Greenhouse reared									
212	18	0	0	0[d]													
163	18	33	9	24[d]													
172	21	19	3	16	0[d]												
188	25	18	0	14	4[d]												
188	35	109	5	34	33	32	5[d]										
163	35	78	11	28	23	11	5[d]										
188	43	81	2	28	19	17	14	1[d]									
150	43	59	7	16	26	4	6	0[d]									
163	46	125	5	31	32	16	31	7	3	0[d]							
236	46	113	2	12	27	27	20	9	10	6[d]							
236	60	80	0	20	12	19	17	4	3	5[d]							
188	60	93	1	16	7	29	17	9	6	8[d]							
163	60	88	3	12	32	11	16	13	1	0[d]							
150	67	155	5	37	32	26	23	7	12	10	3[d]						
212	67	0	0	0	0	0	0	0	0	0	0[d]						
150	67	91	12	20	6	13	10	12	12	4	2[d]						
188	67	124	5	31	16	18	15	8	20	10	1[d]						
163	70	180	9	18	9	22	35	23	18	17	27	2[d]					
236	74	49	0	3	4	5	13	12	10	1	1	0[d]					
236	74	204	2	11	29	37	33	25	24	30	10	3[d]					

Table 9 (Continued).

Female age at mating (hrs.)	Female days alive (±4)	Total eggs	Week of egg production														
			1[a]	2	3	4	5	6	7	8	9	10	11	12	13	14	15
172	74	208	9	35	30	29	34	31	13	8	5	14[d]					
163	77	156	0	19	17	22	29	13	3	14	14	8	17[d]				
163	77	158	8	15	23	12	26	20	28	12	8	6	0[d]				
163	77	129	5	14	26	19	19	15	18	12	0	0	1[d]				
163	81	0	0	0	0	0	0	0	0	0	0	0	0[d]				
163	81	174	14	19	37	29	22	11	7	22	10	3	0[d]				
163	91	186	5	26	33	22	24	17	16	6	2	5	27	2	1[d]		
163	112	256	10	22	23	37	43	18	33	19	13	13	4	5	10	5	1[d]
172	112	96	1	12	0	5	4	4	4	11	8	15	1	15	11	3	2[d]
172	112	113	1	6	7	11	16	11	14	19	4	9	7	7	0	0	1[d]
Subtotal	1890	3175	134	539	507	473	477	270	255	214	108	78	57	29	22	8	4
Mean	63	105.8	.89	2.57	2.59	2.60	2.62	1.61	1.66	1.39	.91	.86	.90	1.04	.79	.38	.19
Total	3840	6818	318	1097	1117	985	966	574	555	460	296	220	82	59	44	28	17
Mean	63.0	111.8	1.04	2.57	2.75	2.56	2.66	1.68	1.80	1.53	1.21	1.21	.62	1.05	1.05	.80	.49

Table 10. Number of E. fabae eggs laid on excised V. faba stems by unmated females

Female days alive (±4)	Total eggs	Week of egg production 1[a]	2	3	4	5	6	7	8	9	10	11	12	13	14	15
39	16	1	3	3	5	4[d]										
43	2	2	0	0	0	0	0[d]									
67	7	0	0	0	2	2	1	2	0	0[d]						
81	18	0	0	0	2	11	3	0	2	0	0	0[d]				
81	96	6	8	8	11	14	21	14	10	1	3	0[d]				
88	109	6	8	4	10	8	11	16	10	15	16	4	1[d]			
88	41	1	1	7	1	5	2	8	1	6	5	4	0[d]			
91	23	0	4	2	1	4	3	4	2	2	1	0	0	0[d]		
112	53	4	9	4	1	5	3	2	4	3	5	11	1	0	1	0[d]
112	19	0	0	0	0	1	2	2	4	2	4	0	1	0	2	1[d]
116	56	0	1	2	0	2	1	8	11	12	9	1	2	5	0	2
116	8	2	2	2	0	1	0	0	0	0	0	1	0	0	0	0
116	44	6	5	3	5	7	6	3	4	2	1	2	0	0	0	0
Total 1150	492	28	41	35	38	64	53	59	48	43	44	23	5	5	3	3
Mean 88.5	.38	.43	.45	.38	.42	.70	.63	.77	.62	.56	.63	.33	.08	.12	.08	.08

[a]Represents first five days only after exposure to males.

Table 11. Number of E. fabae eggs laid on excised V. faba stems during three-day reaction periods following standard preconditioning

Pretest period[a]	Reaction period 1	2	3	4	5	6	7	8
	Test condition:							
	16 hours of light			16 hours of light				
13	2	1	3	3	2	3	10	0
26	12	12	14	7	7	13	12	12
17	8	9	6	5	3	3	5	9
24	13	9	13	12	10	12	16	14
19	12	11	12	9	12	17	12	10
29	12	7	17	16	10	11	10	7
2	2	1	1	0	0	2	0	1
15	5	7	4	5	3	3	1	0
24	6	12	5	3	5	14	9	10
9	3	6	4	4	10	7	2	6
5	1	1	1	1	3	0	3	1
4	3	1	2	1	0	1	1	1
5	0	0	0	0	0	1	3	0
2	0	0	0	0	0	0	0	0
30	8	13	8	10	15	10	12	8
21	8	8	4	9	8	15	9	6
19	5	10	11	7	8	9	12	9
9	11	15	13	8	12	8	14	11
26	4	6	4	7	8	12	11	10
14	5	8	0	3	5	5	6	9
Total				110	121	146	148	124
Mean				1.82	2.00	2.41	2.44	2.05

[a]Two three-day egg counts combined.

Table 11 (Continued).

Pretest period[a]	Reaction period							
	1	2	3	4	5	6	7	8
	16 hours of light			Continuous dark				
14	1	1	14	14	11	14	12	11
28	13	14	6	10	3	7	6	10
7	3	1	4	2	4	7	5	8
19	6	6	10	5	7	4	3	8
10	4	4	0	1	1	0	0	0
27	7	5	18	16	12	9	12	10
5	2	4	5	6	7	10	8	9
17	4	9	11	11	9	8	12	11
5	1	6	10	10	7	9	9	12
16	10	15	14	2	5	8	11	3
5	1	3	7	8	12	11	11	10
6	6	8	10	12	11	19	6	10
25	8	8	13	16	21	15	15	11
16	8	3	4	8	10	13	12	9
3	0	1	1	2	3	8	1	3
6	3	1	0	2	2	4	1	3
26	9	10	11	4	9	20	12	7
31	12	10	11	11	7	12	10	3
3	1	3	0	0	0	1	1	1
13	5	8	3	6	5	13	9	10
Total				146	146	192	156	149
Mean				2.41	2.41	3.17	2.57	2.46
Total 595	224	257	274					
Mean 2.48	1.85	2.12	2.26					

Table 11 (Continued).

Pretest period[a]	Reaction period 1	2	3	4	5	6	7	8
	Test condition:							
	Continuous dark			Continuous dark				
12	5	12	11	12	6	8	10	12
46	9	18	17	6	14	16	12	11
26	4	11	7	13	16	13	17	13
27	20	18	7	15	17	13	12	6
27	10	9	18	11	14	15	7	6
9	2	6	6	10	11	4	4	7
8	1	6	8	8	6	15	16	16
4	0	0	2	1	0	2	1	1
5	2	5	7	6	5	1	1	3
15	14	20	15	10	9	15	17	19
31	8	17	9	10	9	16	19	13
7	2	4	8	9	10	7	12	10
11	9	8	18	20	19	21	22	18
10	0	18	12	3	7	15	11	8
12	3	6	3	6	3	3	3	0
24	12	18	20	10	18	14	14	10
7	1	2	4	3	2	3	2	1
25	9	10	11	16	17	13	8	14
29	10	6	8	12	4	10	6	4
8	5	5	5	5	9	6	11	14
23	8	14	12	5	10	11	9	7
Total				191	206	221	214	193
Mean				3.00	3.24	3.47	3.36	3.18

Table 11 (Continued).

Pretest period[a]	Reaction period							
	1	2	3	4	5	6	7	8
	Continuous dark			16 hours of light				
11	0	3	2	4	4	4	3	7
6	3	4	8	4	4	4	4	4
12	15	15	14	11	8	11	16	12
20	6	9	14	19	14	16	18	13
6	3	3	5	4	6	7	3	4
10	2	5	7	0	6	7	5	7
36	13	18	16	9	7	9	6	9
8	4	6	10	12	12	6	11	6
32	9	12	17	12	15	15	9	10
8	1	13	13	4	5	7	7	7
27	10	11	14	14	14	13	12	8
27	7	16	25	22	14	19	15	9
25	7	7	10	12	13	12	6	8
38	13	12	18	9	12	18	21	10
16	8	5	10	6	3	5	6	7
18	8	10	13	7	11	8	10	6
8	6	8	6	2	2	2	4	5
6	4	6	5	5	3	1	4	2
22	16	6	5	6	9	12	12	5
12	7	12	14	16	13	8	16	12
24	11	11	7	10	6	6	5	6
14	7	12	11	8	6	7	5	4
Total				196	187	197	198	161
Mean				2.94	2.80	2.96	2.97	2.42
Total 725	294	417	450					
Mean 2.92	2.26	3.20	3.45					

Table 12. Statistical analysis: Number of *E. fabae* eggs laid during three-day reaction periods in (a) continuous darkness and (b) 16 hours of light and 8 hours of darkness (data transformed $\sqrt{x+1}$)

Whole - plot analysis

Source of variation	Degrees of freedom	Sum of products: y,y	Sum of products: x,y	Sum of products: x,x	y adjusted for x: Degrees of freedom	y adjusted for x: Mean square
Total	82	159.6349	83.0508	75.1954		
Test conditions	1	15.5332	4.9432	4.5731		
$Error_a$	81	144.1017	78.1076	73.6223	80	0.7654
Test conditions and $error_a$	82	159.6349	83.0508	75.1954	81	
Test conditions adjusted	82				1	6.6726**[a]

Sub - plot analysis

Source of variation	Degrees of freedom	Mean square
Test conditions (T)	1	15.3209 (NS)
Reaction periods (R)	2	3.9814**
(T x R) interaction	2	1.2505*
$Error_b$	162	0.2809

[a]Significant at the 1% level of probability = **, significant at the 5% level = *, and (NS) = non-significant; these symbols will appear as such in following tables.

Table 13. Statistical analysis: Number of E. fabae eggs laid during three-day reaction periods in (a) continuous darkness, (b) 16 hours of light and 8 hours of darkness, (c) continuous darkness following preconditioning and (d) 16 hours of light and 8 hours of darkness following preconditioning (data transformed $\sqrt{x+1}$)

Whole - plot analysis

Source of variation	Degrees of freedom	Sum of products: y,y	Sum of products: x,y	Sum of products: x,x	y adjusted for x: Degrees of freedom	y adjusted for x: Mean square
Total	82	45.1172	68.0278	269.0364		
Test conditions	3	1.1229	2.6978	19.7106		
$Error_a$	79	43.9943	65.3300	249.3258	78	1.9527
Test conditions and $error_a$	82	45.1172	68.0278	269.0364	81	
Test conditions adjusted					3	4.7170 (NS)

Sub - plot analysis

Source of variation	Degrees of freedom	Mean square
Test conditions (T)	3	6.6964
Reaction periods (R)	4	0.8815**
(T x R) interaction	12	0.1411 (NS)
$Error_b$	316	0.2143

Table 14. Number of E. fabae eggs laid on excised V. faba stems during three-day reaction periods following standard preconditioning

Pretest period	Reaction period 1	2	3	4
	Test condition: 21° C.			
13	8	11	14	6
14	4	4	9	10
9	9	5	10	6
10	4	12	10	8
12	1	8	9	6
16	4	7	11	5
14	12	11	13	6
7	8	13	12	12
10	7	10	9	9
12	11	5	8	5
21	8	11	5	2
14	3	6	9	5
18	0	2	8	9
28	8	12	14	14
12	6	1	17	10
17	16	13	6	10
6	6	11	10	5
10	4	12	10	13
20	2	5	6	6
6	12	9	9	6
15	15	9	8	8
14	8	6	11	10
12	6	7	7	10
18	6	9	13	11
19	5	8	7	5
14	5	10	10	12
11	4	5	8	4
4	4	4	5	7
15	10	8	7	8
13	12	11	13	13
10	9	6	11	8
6	9	7	9	9
2	6	8	8	5
13	9	9	5	5
7	7	7	6	0
10	7	3	8	4
Total 452	255	285	335	272
Mean 4.14	2.34	2.61	3.07	2.49

Table 14 (Continued).

	Pretest period	Reaction period			
		1	2	3	4
			Test condition: 25° C.		
	14	10	10	9	8
	10	8	7	9	8
	8	10	10	11	9
	13	4	4	7	6
	8	10	15	11	11
	16	11	14	11	10
	19	8	14	12	13
	16	5	9	7	3
	12	9	5	7	8
	19	20	12	8	10
	6	10	11	4	4
	7	5	7	11	10
	13	9	6	3	3
	15	11	12	8	9
	15	11	11	12	14
	12	11	4	5	3
	13	8	3	5	2
	8	0	0	0	0
	13	10	11	10	8
	11	9	14	8	5
	11	7	8	9	7
	11	8	14	12	6
	15	10	17	7	2
	12	10	5	7	11
	13	6	8	8	10
	15	14	7	11	6
	19	16	15	17	13
	18	13	8	12	13
	9	8	7	9	6
	15	12	12	12	13
	7	6	12	8	4
Total	393	289	292	270	235
Mean	4.18	3.08	3.11	2.87	2.51

Table 14 (Continued).

	Pretest period	Reaction period			
		1	2	3	4
			Test condition: 29° C.		
	16	7	10	18	15
	17	14	11	7	11
	11	13	14	8	16
	13	16	9	15	16
	8	5	11	6	4
	22	12	17	6	6
	8	4	10	6	1
	13	10	18	8	11
	21	15	10	2	5
	13	11	11	10	7
	9	12	14	12	7
	14	15	8	15	5
	9	11	4	10	5
	25	16	19	11	8
	17	11	13	12	5
	13	17	17	4	9
	13	10	13	15	10
	10	9	15	3	0
	4	11	5	4	0
	15	12	11	11	6
	11	15	14	14	9
	15	13	11	14	13
	17	12	13	9	13
	7	8	10	4	0
Total	321	279	288	224	182
Mean	4.41	3.84	3.96	3.08	2.50

Table 14 (Continued).

	Pretest period	Reaction period 1	2	3	4
			Test condition: 31° C.		
	13	21	18	17	3
	16	15	24	16	16
	15	16	17	19	10
	14	4	16	10	12
	12	17	19	15	18
	11	18	11	13	5
	13	6	12	17	10
	13	7	9	11	17
	10	16	13	15	12
	3	4	12	10	1
	19	16	20	16	18
	15	14	24	7	4
	20	22	17	12	15
	8	10	9	6	2
	21	18	17	10	13
	14	15	15	10	2
	12	7	9	4	0
	3	18	16	16	15
	11	18	9	7	9
Total	243	262	287	231	182
Mean	4.22	4.55	4.98	4.01	3.16

Table 15. Number of E. fabae eggs laid on excised V. faba stems during three-day reaction periods following standard preconditioning

	Pretest period			Reaction period			
	1	2	3	1	2	3	4
				Test condition: 23° C.			
	5	0	5	6	8	6	7
	6	8	7	11	10	13	13
	4	1	2	1	0	0	0
	14	8	6	2	6	8	4
	13	15	11	9	8	6	14
	16	7	8	11	6	8	12
	16	7	8	11	6	8	12
	1	6	4	2	6	4	8
	2	6	4	7	4	1	4
	3	4	6	2	0	4	4
	8	4	6	13	9	11	10
	12	6	15	14	13	4	11
	10	6	7	9	8	3	2
	13	9	1	11	7	3	5
	7	6	3	7	6	7	6
	2	3	9	14	0	0	1
	10	6	11	1	11	17	3
	6	10	7	10	8	10	12
	4	1	5	2	2	5	4
	4	5	3	3	4	4	5
	6	3	2	1	0	3	1
	18	8	8	9	8	3	8
	10	12	7	12	10	15	12
	6	4	7	10	13	10	14
	13	11	7	8	11	11	10
	12	4	10	9	9	9	10
	15	10	2	4	12	10	10
	16	8	12	2	7	8	8
	11	9	6	5	3	4	2
	10	6	1	9	10	9	9
	11	5	10	10	10	7	4
	0	10	2	4	7	12	10
Total	270	205	194	220	217	215	223
Mean	2.11	2.11	2.00	2.27	2.24	2.22	2.30

Table 15 (Continued).

	Pretest period			Reaction period			
	1	2	3	1	2	3	4
				Test condition: 25° C.			
	12	11	8	9	10	7	8
	4	3	4	3	4	6	6
	13	3	10	14	8	6	5
	8	12	5	7	6	10	13
	6	4	13	2	10	5	3
	8	7	2	8	4	8	4
	2	8	5	9	12	15	16
	4	4	7	4	3	3	2
	6	3	1	1	0	0	0
	2	3	8	5	4	8	9
	16	10	12	13	16	9	10
	14	9	2	7	9	9	13
	16	8	10	9	13	9	19
	12	7	4	10	12	10	3
	2	4	0	2	2	1	1
	15	13	7	8	5	10	12
	7	4	3	2	5	4	3
	16	13	7	13	13	6	8
	10	9	7	7	11	15	15
	4	14	5	9	12	7	0
	9	7	9	12	7	6	10
	10	10	13	4	8	8	7
	4	7	4	3	6	11	11
	12	8	11	4	2	19	4
	5	7	11	9	6	5	9
	13	6	10	7	14	15	11
	4	2	4	3	1	4	2
	4	1	8	7	9	10	13
Total	238	197	190	191	212	226	217
Mean	2.12	2.32	2.24	2.25	2.50	2.66	2.56

Table 15 (Continued).

	Pretest period 1	2	3	Reaction period 1	2	3	4
				Test condition: 27° C.			
	1	4	8	14	6	13	5
	5	3	2	2	5	1	3
	4	2	1	0	1	0	0
	12	5	10	8	10	9	2
	6	9	6	16	19	12	8
	4	3	3	3	3	3	9
	1	4	10	11	9	11	16
	10	17	8	5	9	14	21
	8	6	3	11	6	10	4
	15	8	5	1	8	6	11
	5	4	2	0	2	1	2
	21	11	12	12	15	15	16
	11	5	4	9	7	2	4
	8	13	7	14	17	11	4
	12	8	11	5	9	5	1
	5	7	5	8	5	5	10
	18	8	6	21	12	5	8
	13	12	11	14	16	10	11
	10	8	10	13	9	7	4
	3	6	6	3	11	20	27
	9	5	5	16	15	17	10
	1	8	7	10	1	7	5
	11	4	5	13	8	13	5
	6	5	9	5	6	6	6
	16	4	3	7	13	10	9
	1	5	6	8	9	8	9
	9	7	7	14	12	8	5
	10	6	6	12	10	8	10
	2	2	0	3	0	0	0
Total	237	199	185	274	269	250	231
Mean	1.98	2.19	2.04	3.01	2.96	2.75	2.54

Table 16. Statistical analysis: Number of *E. fabae* eggs laid during three-day reaction periods in temperatures of 21, 25, 29, and 32° centigrade

Source of variation	Degrees of freedom	Mean square
Whole - plot analysis		
Test conditions	3	7.07987**
32° vs $\frac{(21^\circ+25^\circ+29^\circ)}{3}$ (C_1)	1	14.63105**
29° vs $\frac{(21^\circ+25^\circ)}{2}$ (C_2)	1	5.36365**
25° vs 21° (C_3)	1	1.24490 (NS)
Covariate	1	8.09547**
Error_a	105	.63058
Sub - plot analysis		
Reaction periods	3	10.16117**
Reaction periods x C_1	3	2.91217**
Reaction periods x C_2	3	3.42475**
Reaction periods x C_3	3	2.85784**
Error_b	318	.26594

Table 17. Statistical analysis: Number of *E. fabae* eggs laid during three-day reaction periods in temperatures of 23, 25, and 27° centigrade

Source of variation	Degrees of freedom	Mean square
	Whole - plot analysis	
Test conditions (T)	2	1.63347 (NS)
Linear	1	2.42983 (NS)
Quadratic	1	.83711 (NS)
Covariate	1	29.79522**
$Error_a$	89	1.02504
	Sub - plot analysis	
Reaction periods (R)	3	.83933 (NS)
R x T (linear)	3	1.11704*
R x T (quadratic)	3	.07554 (NS)
$Error_b$	261	.34487

Table 18. Number of *E. fabae* eggs laid on excised *V. faba* stems during three-day reaction periods following standard preconditioning

	Pretest period[a]	Reaction period				
		1	2	3	4	5
		Test condition: Water				
	16	6	0	1	5	2
	22	9	1	2	0	0
	9	5	7	2	2	2
	19	5	15	8	6	4
	12	0	0	3	8	5
	8	2	4	0	0	0
	14	6	2	2	6	11
	10	3	0	6	3	1
	17	2	0	2	4	0
	8	2	1	1	3	2
	13	9	1	5	9	2
	7	4	1	0	5	4
	19	1	4	6	8	2
	7	4	0	0	1	3
	26	4	1	8	4	6
	15	3	5	7	2	6
	26	5	4	1	6	7
	13	6	2	1	0	4
	12	10	1	9	11	0
	20	9	3	5	2	1
	17	4	1	5	6	1
	14	4	5	7	5	0
Total	324	103	58	81	96	60
Mean	2.52	1.56	.88	1.23	1.45	.91

[a]Two three-day egg counts combined.

Table 18 (Continued).

Pretest period[a]	Reaction period				
	1	2	3	4	5
	Test condition: Three percent sucrose solution				
25	10	13	19	13	15
10	8	11	10	7	3
7	3	5	4	3	6
20	0	6	12	6	7
21	8	13	10	14	13
9	7	9	10	8	5
18	13	16	15	12	8
8	12	14	10	9	10
9	8	5	10	7	7
9	4	15	7	11	14
14	11	8	8	7	6
18	6	10	13	11	8
18	10	20	18	17	11
7	1	7	11	7	10
15	8	10	8	10	13
14	4	10	14	6	6
15	7	7	7	10	7
12	3	12	6	7	15
23	11	17	8	12	12
13	5	18	8	10	9
12	9	15	13	13	16
12	5	13	14	15	10
18	6	17	15	15	11
18	13	17	11	10	8
14	3	8	9	11	8
Total 359	175	296	270	251	238
Mean 2.46	2.33	3.94	3.60	3.34	3.17

Table 18 (Continued).

Pretest period[a]	Reaction period 1	2	3	4	5
	Test condition: Six percent sucrose solution				
20	13	11	8	13	11
25	3	13	12	7	13
10	11	8	11	9	7
16	0	11	5	7	4
7	4	11	7	8	6
20	11	7	3	3	8
9	0	10	6	8	13
14	11	18	11	6	12
19	7	5	5	3	8
7	1	4	5	7	4
6	2	4	3	4	3
14	2	8	2	6	8
15	4	6	8	11	11
19	10	14	6	15	11
9	8	10	8	9	8
23	10	11	6	7	9
7	0	2	0	1	1
11	5	8	10	8	9
18	5	14	8	6	11
12	5	7	6	5	6
13	8	20	9	6	7
15	3	9	11	7	7
14	3	12	12	12	10
11	1	9	7	5	9
Total 334	126	232	169	173	196
Mean 2.38	1.75	3.22	2.34	2.40	2.72

Table 18 (Continued).

Pretest period[a]	Reaction period 1	2	3	4	5
	Test condition: Nine percent sucrose solution				
13	5	5	7	3	8
24	7	4	3	2	4
24	6	3	3	2	3
15	4	9	5	0	2
19	6	12	5	6	6
9	0	6	0	5	5
10	7	3	7	3	3
22	5	5	2	0	7
19	5	7	1	3	3
13	0	6	4	0	6
12	5	11	6	5	3
12	6	6	3	1	0
8	2	3	3	1	0
20	3	4	3	2	0
14	9	9	3	2	1
13	1	3	3	1	5
13	6	6	3	3	0
10	3	10	7	4	3
20	0	13	7	6	3
13	4	6	7	8	7
11	0	9	2	7	1
14	2	6	4	3	6
17	5	6	3	4	3
8	2	5	6	2	4
Total 353	93	157	97	73	83
Mean 2.52	1.29	2.18	1.34	1.01	1.15

Table 18 (Continued).

Pretest period[a]	Reaction period 1	2	3	4	5
	Test condition: Twelve percent sucrose solution				
19	0	8	4	5	5
14	1	4	6	1	0
11	4	6	7	0	1
16	0	6	1	2	4
15	6	4	2	5	3
18	0	9	3	3	0
8	0	4	1	4	2
15	10	0	1	3	2
11	8	4	6	6	0
9	1	3	4	0	6
13	0	1	6	1	1
23	5	4	4	1	4
17	2	6	2	1	2
12	0	4	1	0	2
10	0	2	3	7	5
19	6	0	2	3	0
20	0	0	2	0	0
20	6	7	2	1	4
13	0	7	1	3	3
16	7	3	3	4	1
8	0	6	1	3	3
8	0	5	3	3	3
23	0	6	2	0	3
Total 338	56	99	67	56	54
Mean 2.52	.81	1.43	.97	.81	.78

Table 19. Statistical analysis: Numbers of *E. fabae* eggs laid during three-day reaction periods on excised *V. faba* stems held in 3, 6, 9, or 12 per cent sucrose solution and water alone

Source of variation	Degrees of freedom	Mean square
	Whole - plot analysis	
Test conditions (T)	4	27.59160**
Linear	1	15.27668**
Quadratic	1	57.22075**
Cubic	1	37.72646**
Quartic	1	0.14252 (NS)
Covariate	1	5.97729**
$Error_a$	112	0.48287
	Sub - plot analysis	
Reaction periods (R)	4	1.49276**
R x T (linear)	4	1.40062**
R x T (quadratic)	4	2.03896**
R x T (cubic)	4	.56907*
R x T (quartic)	4	.22643 (NS)
$Error_b$	452	.22766

Table 20. Number of *E. fabae* eggs laid on excised tissues of *Solanum* species during three-day reaction periods and during standard preconditioning and recovery on excised *V. faba* stems

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
					Three percent sucrose solution					
S. chacoense P.I. 133-085	12	-	-	0	0	-	-	0	0	11
	8	-	-	0	0	-	-	0	0	8
	6	-	-	0	0	-	-	0	0	8
	7	-	-	0	0	-	-	0	0	0
	9	-	-	0	0	-	-	0	0	11
	5	-	-	0	0	-	-	0	0	7
	9	-	-	0	0	-	-	0	0	4
	13	-	-	0	0	-	-	0	0	9
	11	-	-	0	0	-	-	0	0	8
	4	-	-	0	0[d]				-	-
Subtotal	84				0				0	66
Mean	2.77				0				0	2.42
					Water					
	20	-	-	4	4	-	-	0	0	10
	5	-	-	0	0	-	-	0	0	4
	5	-	-	5	5[d]				-	-
	16	-	-	0	0[d]				-	-
	11	-	-	0	0	-	-	1	1[d]	-
Subtotal	57				9				1	14
Total	141				9				1	80

[a]Leaf or leaflet.

[b]Petiole or rachis.

[c]Stem.

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1: 1[a]	2[b]	3[c]	Total	Reaction period 2: 1[a]	2[b]	3[c]	Total	Recovery period
					Three percent sucrose solution					
S. chacoense P.I. 133-085	20	7[e]		-	7	3[e]		-	3	11
	7	1		-	1	0		-	0[d]	-
	12	6		-	6	2		-	2	8
	5	4		-	4	7		-	7	8
	7	5		-	5	0		-	0	4
	15	3		-	3[d]				-	-
	20	3		-	3	0		-	0[d]	-
	8	0		-	0	3		-	3	4
	11	8		-	8	8		-	8	8
	7	4		-	4	5		-	5	11
Subtotal	112				41				28	54
Mean	3.70				1.35				1.03	2.54
					Water					
	20	1		-	1[d]				-	-
	17	6		-	6	0		-	0[d]	-
	6	0		-	0[d]	0			-	-
	7	3		-	3	0		-	0[d]	-
	6	2		-	2	0		-	0[d]	-
Subtotal	56				12				0	-
Total	168				53				28	54

[e]Leaf or leaflet and petiole or rachis combined.

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1: 1[a]	2[b]	3[c]	Total	Reaction period 2: 1[a]	2[b]	3[c]	Total	Recovery period
					Three percent sucrose solution					
S. demissum	11	8[e]		0	8	5[e]		0	5	8
P.I. 160-220.2	10	6		1	7	3		0	3	14
	7	10		0	10	3		0	3	22
	6	1		4	5	2		4	6	5
	7	6		0	6	5		0	5	3
	15	9		1	10	8		0	8	8
	12	0		0	0[d]				-	-
	15	9		0	9	0		0	0[d]	-
	14	2		2	4	7		0	7	6
	5	2		0	2	5		0	5	6
Subtotal	102				61				42	72
Mean	3.37				2.01				1.54	2.97
					Water					
	5	5		1	6	0		0	0[d]	-
	9	6		0	6	0		0	0[d]	-
	7	4		0	4	0		0	0[d]	-
	8	4		2	6	1		0	1	0[d]
	10	1		2	5[d]				-	-
Subtotal	39				27				1	0
Total	141				88				43	72

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. jamesii	4		-	2	2	0[e]	1		1	4
P.I. 275-264.1	12		-	4	4	4	4		8	5
	8		-	4	4	0	6		6	9
	10		-	5	5	5	0		5	5
	9		-	6	6	0	2		2	4
	15		-	7	7	2	6		8	14
	13		-	6	6	3	2		5	12
	8		-	0	0	4	1		5	13
	12		-	2	2	5	0		5	3
	6		-	5	5	1	0		1	0
Subtotal	97				41				46	69
Mean	3.20				1.35				1.52	2.28
		Water								
	14		-	0	0[d]				-	-
	14		-	5	5	0	0		0[d]	-
	8		-	0	0[d]				-	-
	4		-	0	0[d]				-	-
	4		-	0	0[d]				-	-
Subtotal	44				5				-	-
Total	141				46				46	69

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. chiquidenum	6	7[e]	15		22	16[e]	1		17	15
P.I. 275-269.1	7	0	12		12	0	14		14	8
	8	0	11		11	0	6		6	0
	10	0	10		10	0	2		2	0
	15	12	1		13	5	6		11	8
Subtotal	46				68				50	31
Mean	3.04				4.49				3.30	2.05
		Water								
	15	0	0		0		1		1	0
	9	0	1		1[d]				-	-
	8	0	0		0[d]				-	-
	6	0	0		0[d]				-	-
	20	8	2		10[d]				-	-
Subtotal	58				11				1	0
Total	104				79				51	31

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1: 1[a]	2[b]	3[c]	Total	Reaction period 2: 1[a]	2[b]	3[c]	Total	Recovery period
				Three percent sucrose solution						
S. cardiophyllum	10	0	1		1[d]				-	-
P.I. 184-766	13	3	4		7	1	2		3	10
	21	4	1		5	4	4		8	13
	7	2	2		4	0	1		1	4
	4	7	4		11	3	3		6	5
Subtotal	55				28				18	32
Mean	3.63				1.85				1.~~48~~	2.64
				Water						
	10	3	2		5[d]				-	-
	8	0	0		0[d]				-	-
	9	0	0		0[d]				-	-
	10	0	0		0[d]				-	-
	12	0	0		0[d]				-	-
Subtotal	49				5				-	-
Total	104				33				18	32

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
				Three percent sucrose solution						
S. curtilobum	13	8[e]	-		8	12[e]	-		12	11
P.I. 225-651.4	7	8	-		8	8	-		8	6
	11	19	-		19	8	-		8	17
	18	13	-		13	14	-		14	11
	14	7	-		7	7	-		7	12
Subtotal	63				55				49	57
Mean	4.16				3.63				3.23	3.76
				Water						
	17	6	-		6[d]				-	-
	4	0	-		0[d]				-	-
	5	5	-		5	5	-		5	3
	14	8	-		8	6	-		6	6
	6	1	-		1[d]				-	-
Subtotal	46				20				11	9
Total	109				75				60	66
				Three percent sucrose solution						
V. faba	9	-	-	13	13	-	-	13	13	10
Control-b	7	-	-	7	7	-	-	7	7	8
	12	-	-	17	17	-	-	15	15	14
	11	-	-	9	9	-	-	10	10	9
	8	-	-	15	15	-	-	11	11	10
	12	-	-	20	20	-	-	18	18	15
	8	-	-	5	5	-	-	10	10	8
	8	-	-	7	7	-	-	11	11	12
	10	-	-	12	12	-	-	8	8	4
	8	-	-	9	9	-	-	7	7	9
Subtotal	93				114				110	99
Mean	3.07				3.76				3.63	3.27

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
					Three percent sucrose solution					
V. faba	10	-	-	14	14	-	-	11	11	5
Control-c	13	-	-	18	18	-	-	17	17	14
	16	-	-	17	17	-	-	10	10	9
	12	-	-	6	6	-	-	6	6	3
	16	-	-	13	13	-	-	8	8	11
	18	-	-	14	14	-	-	16	16	16
	9	-	-	11	11	-	-	3	3	6
	12	-	-	21	21	-	-	8	8	10
	12	-	-	21	21	-	-	18	18	12
	13	-	-	9	9	-	-	10	10	7
Subtotal	131				144				107	93
Mean	4.32				4.75				3.53	3.07
					Water					
	8	-	-	1	1	-	-	0	0	2
	13	-	-	13	13	-	-	4	4	4
	9	-	-	10	10	-	-	1	1	0
	7	-	-	13	13	-	-	8	8	7
	8	-	-	4	4	-	-	1	1	6
Subtotal	45				41				14	19
Total	176				185				121	112

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. kurtzianum	6	0	0	0	0	3	0	-	3	6
P.I. 175-434.1	12	0	3	1	4	1	0	-	1	2
	6	2	0	0	2	2	0	-	2	0
	13	0	6	0	6	1	0	-	1	5
	16	0	0	0	0[d]				-	-
	20	1	0	1	2	3	0	-	3	2
	21	0	0	0	0	3	0	-	3[d]	-
	18	0	7	0	7	2	1	-	3	6
	16	3	5	0	8	2	1	-	3	10
	11	1	0	0	1	4	0	-	4	10
Subtotal	139				30				23	41
Mean	4.59				.99				.84	1.69
		Water								
	15	2	0	1	3	0	0	-	0	0
	11	0	3	0	3	0	0	-	0[d]	-
	6	0	2	0	2	2	0	-	2[d]	-
	8	1	0	1	2	0	0	-	0	1
	7	4	0	0	4	1	0	-	1	2
Subtotal	47				14				3	3
Total	186				44				26	44

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. spegazzinii	6	8	0	0	8	3	0	-	3	7
P.I. 218-218.7	12	4	7	0	11	3	0	-	3	9
	13	0	0	15	15	1	0	-	1	5
	13	0	0	0	0[d]				-	-
	15	0	0	3	3	4	0	-	4	3
	11	0	16	0	16	2	5	-	7	8
	22	0	0	8	8	4	0	-	4	1
	16	5	1	0	6[d]				-	-
	14	7	1	0	8	0	0	-	0	4
	16	4	2	0	6[d]				-	-
Subtotal	138				81				22	37
Mean	4.55				2.67				1.04	1.74
		Water								
	6	1	0	0	1	0	0	-	0	0
	4	0	0	4	4	0	0	-	0[d]	-
	10	4	4	0	8	0	0	-	0[d]	-
	7	0	7	0	7	0	0	-	0[d]	-
	14	4	5	0	9	0	1	-	1[d]	-
Subtotal	41				29				1	0
Total	179				110				23	37

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
					Three percent sucrose solution					
S. sucrense	11	12	2	0	14	10	0	-	10	9
P.I. 230-465.6	11	4	9	4	17	0	0	-	0[d]	-
	8	4	3	0	7	6	0	-	6	9
	17	4	4	0	8	7	0	-	7	9
	13	6	7	0	13	14	0	-	14	11
	16	2	20	0	22	6	5	-	11	10
	12	0	0	0	0	0	0	-	0[d]	-
	16	1	11	0	12	8	0	-	8	18
	13	2	15	2	19	7	7	-	14	15
	15	5	8	10	23	8	10	-	18	15
Subtotal	132				135				88	96
Mean	4.36				4.46				2.90	3.96
					Water					
	11	4	8	0	12[d]				-	-
	11	2	10	0	12	5	10	-	15	1[d]
	5	1	0	0	1	1	0	-	1	0
	4	1	6	0	7	7	2	-	9	3
	12	3	10	5	18	4	2	-	6	10
Subtotal	43				50				31	14
Total	175				185				119	110

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. simplicifolium	8	6	-	-	6	2	-	-	2	2
P.I. 218-224.2	9	3	-	-	3	2	-	-	2	4
	8	13	-	-	13	2	-	-	2	6
	16	7	-	-	7	8	-	-	8	14
	12	-	-	7	7	5	-	-	5	9
	7	0	-	-	0	4	-	-	4	14
	13	2	-	-	2[d]				-	-
	26	10	-	-	10	8	-	-	8	7
	20	9	-	-	9	4	-	-	4	1
	4	1	-	-	1	0	-	-	0	10
Subtotal	123				58				35	67
Mean	4.06				1.91				1.28	2.46
		Water								
	15	6	-	-	6	-	-	0	0[d]	-
	8	-	-	1	1	4	-	-	4	0[d]
	8	1	-	-	1[d]				-	-
	11	3	-	-	3[d]				-	-
	13	2	-	-	2	0	-	-	0[d]	-
Subtotal	55				13				4	0
Total	178				71				39	67

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. tarijense	15	8	3	-	11	2	6	0	8	6
P.I. 230-466.3	15	4	0	-	4	6	2	0	8	11
	15	4	0	-	4	0	2	5	7	11
	20	0	3	-	3	7	0	-	7	8
	18	0	0	0	0	3	0	-	3	12
	8	0	0	7	7	1	0	3	4	6
	12	1	0	1	2	0	0	0	0[d]	-
	13	3	0	-	3	2	6	0	8	6
	14	8	5	0	13	0	8	0	8	8
	7	0	0	3	3	0	5	3	8	5
Subtotal	137				50				61	73
Mean	4.52				1.65				2.01	2.68
		Water								
	8	8	1	0	9	3	1	0	4	5
	4	0	0	2	2	1	0	-	1	0
	10	4	5	0	9	5	3	-	8	0
	13	0	3	1	4	0	0	0	0[d]	-
	8	0	0	0	0[d]				-	-
Subtotal	43				24				13	5
Total	180				74				74	78

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. brachycarpum	22	1	4	-	5[d]				-	-
P.I. 251-721	14	1	3	-	4	0	0	-	0	4
	7	4	1	-	5	1	0	-	1	4
	11	0	2	-	2	1	0	-	1	0
	9	1	2	-	3	1	0	-	1	5
	13	5	1	-	6	3	2	-	5	9
	6	2	0	-	2	0	0	-	0	0[d]
	8	3	0	-	3	5	0	-	5	7
	11	5	0	-	5	0	0	-	0	3
	8	3	0	-	3[d]				-	-
Subtotal	109				38				13	32
Mean	3.60				1.25				.54	1.32
		Water								
	14	6	0	-	6[d]				-	-
	15	3	0	-	3[d]				-	-
	8	8	1	-	9	0	0	-	0	2
	11	4	0	-	4	0	0	-	0[d]	-
	12	7	1	-	8	3	0	-	3[d]	-
Subtotal	60				30				3	2
Total	169				68				16	34

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
	Three percent sucrose solution									
S. chacoense	14	5	0	-	5[d]				-	-
P.I. 133-619	8	10	0	-	10	1	0	-	1	3
	9	2	2	-	4	0	0	-	0	0
	9	4	1	-	5	0	1	-	1	0
	11	5	0	-	5	1	1	-	2	0
	12	2	3	-	5	2	1	-	3	7
	14	4	4	-	8	0	2	-	2	0
	8	4	0	-	4	0	0	-	0[d]	-
	8	1	4	-	5	0	0	-	0[d]	-
	20	5	0	-	5	0	0	-	0	1
Subtotal	113				56				9	11
Mean	3.73				1.85				.33	.52
	Water									
	7	4	0	-	4	0	0	-	0[d]	-
	18	0	0	-	0[d]				-	-
	10	3	0	-	3	0	0	-	0[d]	-
	6	1	0	-	1[d]				-	-
	18	2	2	-	4[d]				-	-
Subtotal	59				12				0	-
Total	172				68				9	11

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1: 1[a]	2[b]	3[c]	Total	Reaction period 2: 1[a]	2[b]	3[c]	Total	Recovery period
		Three percent sucrose solution								
S. vernei P.I. 230-468.2	14	5	11	0	16	1	12	1	14	17
	7	5	0	0	5	0	11	3	14	10
	16	5	4	0	9	5	1	13	19	22
	12	6	10	1	17	6	7	0	13	22
	11	2	1	10	13	0	12	0	12	4
	9	2	1	0	3	1	12	3	16	4
	6	4	2	0	6	7	2	4	13	9
	15	13	12	2	27	0	5	9	14	16
	5	7	8	1	16	1	4	3	8	10
	7	2	2	0	4	3	7	3	13	1
Subtotal	102				116				136	115
Mean	3.37				3.83				4.49	3.80
		Water								
	8	0	4	2	6	0	0	0	0[d]	-
	8	2	1	0	3	0	0	0	0	2
	13	8	7	1	16	0	0	0	0[d]	-
	11	2	9	0	11	0	0	0	0	7
	14	2	6	0	8[d]				-	-
Subtotal	54				44				0	9
Total	156				160				136	124

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1: 1[a]	2[b]	3[c]	Total	Reaction period 2: 1[a]	2[b]	3[c]	Total	Recovery period
				Three percent sucrose solution						
V. faba Control-d	19	-	-	14	14	-	-	14	14	13
	6	-	-	11	11	-	-	9	9	6
	24	-	-	15	15	-	-	7	7	13
	9	-	-	5	5	-	-	16	16	8
	7	-	-	4	4	-	-	5	5	7
	8	-	-	8	8	-	-	8	8	5
	9	-	-	3	3	-	-	4	4	5
	16	-	-	17	17	-	-	9	9	14
	16	-	-	18	18	-	-	15	15	13
	15	-	-	11	11	-	-	10	10	11
Subtotal	129				106				97	95
Mean	4.26				3.50				3.20	3.14
				Water						
	11	-	-	6	6	-	-	6	6	2
	13	-	-	4	4	-	-	0	0	10
	9	-	-	13	13	-	-	2	2[d]	-
	13	-	-	2	2	-	-	0	0[d]	-
	14	-	-	6	6	-	-	2	2	0
Subtotal	60				31				10	12
Total	189				137				107	107

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. polyadenium	24	0	0	0	0	-	-	2	2	10
P.I. 275-238	10	0	0	0	0	-	-	4	4	0
	6	0	0	0	0	-	-	2	2	12
	9	0	0	0	0	-	-	1	1	2
	5	-	-	0	0	0	0	0	0[d]	-
	12	0	0	0	0	0	0	0	0[d]	-
	17	0	0	-	0	0	0	0	0	7
	24	0	0	-	0	-	-	1	1[d]	-
	13	0	0	-	0	0	0	0	0	1
	8	-	-	3	3	0	0	-	0	1
Subtotal	128				3				10	33
Mean	4.22				.10				.33	1.56
		Water								
	15	0	0	0	0[d]				-	-
	13	0	0	0	0	0	0	-	0[d]	-
	13	0	0	-	0	0	0	-	0[d]	-
	7	0	0	1	1	-	-	2	2[d]	-
	12	0	0	0	0	0	0	-	0[d]	-
Subtotal	60				1				2	-
Total	188				4				12	33

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. acroscopicum	11	0	7	5	12	1	11	0	12	5
P.I. 230-495.4	17	2	12	4	18	2	10	1	13	3[d]
	14	0	11	0	11	3	4	0	7	4
	14	0	4	0	4	3	0	0	3	5
	14	0	12	6	18	3	14	0	17	7
	17	2	15	0	17	6	9	5	20	15
	4	0	3	0	3	3	0	0	3	15
	11	3	12	0	15	0	13	0	13	16
	12	2	8	1	11	4	8	0	12	5[d]
	20	0	15	6	21	6	19	1	26	10[d]
Subtotal	134				130				126	85
Mean	4.42				4.29				4.16	2.80
		Water								
	1	0	1	0	1	0	0	0	0	0
	18	0	13	0	13	2	8	0	10	10
	22	2	14	0	16	1	8	0	9	13
	10	4	6	0	10	0	7	0	7	4
	13	0	0	2	2	0	4	0	4	13
Subtotal	64				42				30	40
Total	198				172				156	125

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
Three percent sucrose solution										
S. phureja	13	-	-	4	4	-	-	7	7	12
P.I. 225-673.4	14	-	-	10	10	-	-	14	14	15
	28	5	3	-	8	-	-	7	7	12
	14	5	3	-	8	-	-	10	10	10
	18	2	5	-	7	-	-	7	7	6[d]
	15	2	12	-	14	6	14	-	20	18
	2	5	3	-	8	4	4	-	8	4
	12	9	0	-	9	0	0	-	0[d]	-
	8	11	0	-	11	2	6	-	8	10
	9	1	10	-	11	0	11	2	13	19
Subtotal	133				90				94	106
Mean	4.39				2.97				3.10	3.89
Water										
	12	0	0	4	4	0	0	0	0[d]	-
	14	0	0	0	0[d]				-	-
	12	1	2	0	3	0	1	0	1[d]	-
	14	3	8	0	11	0	0	0	0[d]	-
	13	0	0	3	3	0	0	0	0[d]	-
Subtotal	65				21				1	-
Total	198				111				95	106

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1: 1[a]	2[b]	3[c]	Total	Reaction period 2: 1[a]	2[b]	3[c]	Total	Recovery period
		Three percent sucrose solution								
S. demissum	14	0	6	1	7	0	0	3	3	5
P.I. 161-725.5	4	0	11	0	11	2	2	0	4	1
	20	1	1	0	2	0	0	0	0	0[d]
	18	0	4	0	4	1	0	1	2	2
	12	0	5	0	5	2	3	0	5	2
	6	0	5	3	8	0	4	3	7	2
	14	0	1	3	4	0	0	1	1	4
	22	0	2	15	17	0	1	9	10	11
	12	4	1	0	5	0	1	0	1	0
	14	0	4	0	4	0	0	0	0	4
Subtotal	136				67				33	31
Mean	4.49				2.21				1.09	1.02
		Water								
	11	0	0	1	1	0	0	0	0[d]	-
	14	0	3	0	3[d]				-	-
	10	0	2	2	4[d]				-	-
	15	1	4	0	5[d]				-	-
	14	0	1	0	1[d]				-	-
Subtotal	64				14				0	-
Total	200				81				33	31

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. maglia P.I. 224-460	9	3	0	-	3	5	0	-	5	15
	14	1	1	-	2	0	0	-	0	12
	12	2	0	-	2	3	0	-	3	7
	15	6	0	-	6	6	0	-	6	9
	16	5	0	-	5	6	0	-	6	7
	7	2	0	-	2	0	1	-	1	15
	14	0	1	-	1	0	0	-	0	12
	13	0	0	-	0[d]					-
	12	2	0	-	2	0	0	-	0	10
	20	2	1	-	3	0	0	-	0[d]	-
Subtotal	132				26				21	87
Mean	4.36				.86				.77	3.59
		Water								
	11	3	0	-	3	7	0	-	7	10
	8	4	0	-	4	1	0	-	1	10
	16	2	0	-	2	0	0	-	0[d]	-
	11	4	0	-	4	3	0	-	3	7
	8	2	0	-	2	0	0	-	0	1
Subtotal	54				15				11	28
Total	186				41				32	115

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. chacoense	3	0	0	-	0	0	0	-	0	2
P.I. 230-581.11	6	1	0	-	1	0	0	-	0	0
	11	0	0	-	0	0	0	-	0	8
	14	2	0	-	2	0	0	-	0	0
	14	2	3	-	5	0	0	-	0	0
	16	0	0	-	0	0	0	-	0	1
	14	0	0	-	0	0	1	-	1	3
	12	1	2	-	3[d]				-	-
	19	0	0	-	0[d]				-	-
	15	0	0	-	0[d]				-	-
Subtotal	124				11				1	14
Mean	4.09				.36				.03	.66
		Water								
	3	0	0	-	0[d]				-	-
	11	0	1	-	1[d]				-	-
	21	3	2	-	5	0	0	-	0[d]	-
	22	0	0	-	0[d]				-	-
	12	0	0	-	0[d]				-	-
Subtotal	69				6				0	-
Total	193				17				1	14

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. chacoense	1	0	0	-	0	0	0	-	0	2
P.I. 197-760.7	29	0	3	-	3	5	1	-	6	20
	12	2	6	-	8	4	2	-	6	11
	13	0	0	-	0[d]				-	-
	16	3	0	-	3	0	0	-	0	0
	20	0	2	-	2	0	0	-	0	10
	23	3	1	-	4	0	0	-	0	11
	8	0	1	-	1	0	0	-	0	7
	18	1	1	-	2[d]				-	-
	1	0	0	-	0[d]				-	-
Subtotal	141				23				12	61
Mean	4.65				.76				.57	2.88
		Water								
	14	0	0	-	0[d]				-	-
	12	0	0	-	0[d]				-	-
	12	1	0	-	1[d]				-	-
	17	0	0	-	0	0	0	-	0[d]	-
	2	0	0	-	0	0	0	-	0	0
Subtotal	57				1				0	0
Total	198				24				12	61

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. steno-	13	0	4	0	4[d]				-	-
phyllidium	10	0	1	0	1[d]				-	-
P.I. 255-528.2	8	0	2	3	5	0	0	0	0[d]	-
	14	0	8	2	10	0	4	5	9	8
	16	0	15	0	15	2	8	0	10	5[d]
	18	0	6	7	13	0	9	0	9	7
	12	0	3	7	10	0	1	0	1	10
	13	0	0	10	10	2	7	5	14	10
	3	2	0	6	8	0	8	2	10	0
	12	0	10	6	16	0	0	12	12	11
Subtotal	119				92				65	51
Mean	3.93				3.04				2.68	2.40
		Water								
	20	0	4	1	5[d]				-	-
	17	0	0	2	2[d]				-	-
	14	0	3	0	3[d]				-	-
	14	0	0	0	0[d]				-	-
	11	0	0	3	3[d]				-	-
Subtotal	76				13				-	-
Total	195				105				65	51

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
				Three percent sucrose solution						
V. faba Control-e	5	-	-	12	12	-	-	11	11	16
	11	-	-	6	6	-	-	9	9	8
	6	-	-	10	10	-	-	16	16	6
	15	-	-	14	14	-	-	15	15	11
	13	-	-	14	14	-	-	16	16	12
	5	-	-	7	7	-	-	14	14	14
	4	-	-	14	14	-	-	11	11	14
	18	-	-	9	9	-	-	11	11	15
	16	-	-	8	8	-	-	13	13	20
	2	-	-	4	4	-	-	2	2	4
Subtotal	95				98				118	120
Mean	3.14				3.23				3.89	3.96
				Water						
	7	-	-	9	9	-	-	5	5	6
	4	-	-	7	7	-	-	2	2[d]	-
	5	-	-	16	16	-	-	10	10	6
	7	-	-	9	9	-	-	7	7	9
	9	-	-	3	3	-	-	0	0[d]	-
Subtotal	32				44				24	21
Total	127				142				142	141

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. hougasii	13	0	2	0	2	4	4	-	8	9
P.I. 161-740.4	16	1	2	0	3	1	0	-	1	6
	11	3	0	0	3	0	0	-	0	10
	14	0	0	0	0	5	0	-	5	5
	4	1	0	0	1	0	5	-	5	0
	11	2	1	0	3	3	0	-	3	4
	12	3	3	0	6	0	2	-	2	1
	5	2	1	0	3	0	0	-	0	8
	12	2	3	0	5	2	0	-	2	3
	1	1	0	0	1	4	0	-	4	1
Subtotal	99				27				30	47
Mean	3.27				.89				.99	1.55
		Water								
	3	0	0	0	0	5	0	-	5	0
	8	0	5	3	8	0	0	-	0	2
	9	0	1	3	4	0	0	-	0[d]	-
	8	3	1	0	4	1	0	-	1	7
	1	2	2	0	4	1	0	-	1[d]	-
Subtotal	29				20				7	9
Total	128				47				37	56

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1: 1[a]	2[b]	3[c]	Total	Reaction period 2: 1[a]	2[b]	3[c]	Total	Recovery period
				Three percent sucrose solution						
S. brachycarpum	4	2	0	-	2	0	0	-	0	11
P.I. 275-180.5	11	3	2	-	5	5	0	-	5	7
	10	3	0	-	3	10	0	-	10	10
	8	7	1	-	8	5	2	-	7	7
	15	9	1	-	10	2	0	-	2	12
	6	7	0	-	7	3	3	-	6	3
	6	1	0	-	1	3	2	-	5	6
	6	3	3	-	6	2	3	-	5	8
	6	2	0	-	2	6	3	-	9	5
	4	4	1	-	5	5	3	-	8	8
Subtotal	76				49				57	77
Mean	2.51				1.62				1.88	2.54
				Water						
	11	5	0	-	5	0	0	-	0[d]	-
	11	1	0	-	1	4	3	-	7	13
	7	13	0	-	13	0	0	-	0[d]	-
	12	4	0	-	4	1	0	-	1[d]	-
	10	4	0	-	4[d]				-	-
Subtotal	51				27				8	13
Total	127				76				65	90

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. megistacrolobum	9	4	9	1	14	0	12	1	13	13
P.I. 210-034.1	12	2	2	0	4	2	0	0	2[d]	-
	8	6	4	3	13	3	1	0	4	1
	10	6	4	0	10	6	4	0	10	6
	10	2	4	2	8	8	3	0	11	9
	13	3	1	0	4	0	2	5	7	10
	4	0	5	0	5	2	4	2	8	6
	8	5	5	1	11	9	5	0	14	14
	7	6	0	11	17	5	8	0	13	16
	1				0				0	0
Subtotal	82				86				82	75
Mean	2.71				2.84				2.71	2.75
		Water								
	11	2	4	3	9	0	2	0	2[d]	-
	7	3	6	0	9	0	7	0	7	6
	12	3	4	7	14	0	5	0	5[d]	-
	1	0	0	0	0	3	3	3	9	0
	17	9	0	0	9[d]				-	-
Subtotal	48				41				23	6
Total	130				127				105	81

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1: 1[a]	2[b]	3[c]	Total	Reaction period 2: 1[a]	2[b]	3[c]	Total	Recovery period
					Three percent sucrose solution					
S. acaule P.I. 210-032.1	9	2	3	0	5	1	4	0	5	9
	5	0	6	1	7	0	7	0	7	10
	7	0	6	7	13	3	1	0	4	8
	7	2	2	2	6	2	0	0	2	8
	8	0	7	0	7	2	0	10	12	17
	10	0	5	8	13	2	6	0	8	16
	9	0	10	3	13	2	2	0	4	6
	8	2	4	0	6	0	4	0	4	9
	9	3	3	0	6	5	0	0	5	10
	10	0	4	8	12	4	4	0	8	4
Subtotal	82				88				59	97
Mean	2.71				2.90				1.95	3.20
					Water					
	5	3	4	0	7	0	6	0	6	11
	6	0	4	6	10	2	7	0	9	10
	7	0	4	4	8	0	0	0	0	11
	10	0	1	10	11	4	0	0	4	3
	16	0	4	3	7	0	3	0	3	10
Subtotal	44				43				22	45
Total	126				131				81	142

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. polyadenium P.I. 230-463	3	0	0	-	0	0	0	-	0[d]	-
	8	0	0	-	0	0	0	-	0[d]	-
	3	0	0	-	0	0	1	-	1	10
	13	0	0	-	0	0	0	0	0[d]	-
	7	0	0	-	0[d]				-	-
	6	0	0	-	0	0	0	-	0	12
	4	0	0	-	0	0	0	-	0	3
	4	0	0	-	0	0	0	-	0	7
	15	0	0	-	0[d]				-	-
	14	0	0	-	0[d]				-	-
Subtotal	77				0				1	32
Mean	2.54				0				.05	1.06
		Water								
	6	0	0	-	0[d]				-	-
	7	0	1	0	1	0	0	0	0	1
	11	0	0	0	0	0	1	0	1	5
	9	0	0	0	0[d]				-	-
	13	0	0	3	3[d]				-	-
Subtotal	46				4				1	6
Total	123				4				2	38

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
					Three percent sucrose solution					
S. gourlayi	10	0	9	0	9	6	2	0	8	12
P.I. 210-038.1	14	0	10	6	16	3	15	0	18	10
	10	1	5	0	6	14	2	0	16	5
	9	3	6	0	9	5	7	0	12	4
	13	4	12	0	16	0	16	1	17	8
	12	7	10	0	17	0	9	0	9	7
	6	4	5	0	9	4	10	0	14	16
	11	0	10	4	14	9	6	0	15	9
	1	0	8	3	11	12	5	0	17	13
	10	7	7	0	14	0	16	2	18	9
Subtotal	96				121				144	93
Mean	3.17				3.99				4.75	3.07
					Water					
	11	0	5	0	5	0	0	0	0	0
	7	5	5	0	10	0	0	0	0	7
	12	4	11	0	15	4	1	0	5	9
	3	0	9	4	13	0	1	0	1	6
	1	0	2	4	6	0	2	0	2	2
Subtotal	34				49				8	24
Total	130				170				152	117

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
					Three percent sucrose solution					
S. chacoense P.I. 189-219.8	8	0	1	-	1	5	6	-	11	5
	5	7	0	-	7	5	2	-	7	0
	8	7	0	-	7	3	8	-	11	10
	9	6	1	-	7	0	0	-	0[d]	-
	7	3	0	-	3	4	1	-	5	8
	8	3	2	-	5	3	2	-	5	8
	9	7	0	-	7	3	3	-	6	7
	9	6	1	-	7	1	0	-	1	2
	12	0	4	-	4	0	0	-	0[d]	-
	13	2	2	-	4[d]				-	-
Subtotal	88				52				46	40
Mean	2.90				1.72				1.69	1.88
					Water					
	4	0	1	-	1	7	0	-	7	7
	13	1	1	-	2	1	0	-	1[d]	-
	6	1	1	-	2[d]				-	-
	10	0	0	-	0	3	0	-	3	3
	10	1	0	-	1[d]				-	-
Subtotal	43				6				11	10
Total	131				58				57	50

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. chacoense	14	0	0	-	0[d]				-	-
P.I. 133-124	12	2	1	-	3	3	1	-	4	0
	11	2	1	-	3	1	0	-	1[d]	-
	11	4	2	-	6	0	0	-	0	0
	4	0	3	-	3	1	2	-	3	6
	7	4	0	-	4	1	0	-	1	3
	7	4	0	-	4	0	0	-	0	6
	9	2	3	-	5	1	1	-	2	6
	4	0	0	-	0	0	0	-	0[d]	-
	6	0	0	-	0[d]				-	-
Subtotal	85				28				11	21
Mean	2.80				.92				.45	1.16
		Water								
	2	3	0	-	3	3	0	-	3	9
	11	0	0	-	0[d]				-	-
	8	0	0	-	0[d]				-	-
	9	0	1	-	1	0	0	-	0	4
	11	2	1	-	3	0	0	-	0	4
Subtotal	41				7				3	17
Total	126				35				14	38

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
V. faba Control-f	4	-	-	1	1	-	-	4	4	4
	12	-	-	11	11	-	-	12	12	7
	11	-	-	10	10	-	-	8	8	8
	11	-	-	10	10	-	-	10	10	11
	1	-	-	3	3	-	-	4	4	3
	3	-	-	4	4	-	-	5	5	15
	11	-	-	10	10	-	-	10	10	13
	12	-	-	10	10	-	-	4	4	8
	5	-	-	15	15	-	-	5	5	9
	8	-	-	14	14	-	-	9	9	7
Subtotal	78				88				71	85
Mean	2.57				2.90				2.34	2.80
		Water								
	16	-	-	4	4	-	-	2	2	4
	13	-	-	13	13	-	-	10	10	3
	11	-	-	4	4	-	-	8	8	7
	10	-	-	4	4	-	-	5	5	8
	7	-	-	0	0[d]				-	-
Subtotal	57				25				25	22
Total	135				113				96	107

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. demissum	4	0	7	1	8	0	0	0	0	7
P.I. 161-181.10	9	0	3	7	10	0	4	2	6	8
	3	0	3	4	7	0	2	0	2	0
	7	0	4	0	4	0	6	0	6	5
	12	0	4	6	10	2	5	0	7	17
	11	0	6	2	8	0	7	0	7	15
	16	0	6	1	7	0	4	0	4	15
	12	0	8	2	10	1	0	0	1	11
	12	0	4	0	4	0	0	0	0	12
	12	0	6	4	10	0	2	0	2	0
Subtotal	98				78				35	90
Mean	3.23				2.57				1.16	2.97
		Water								
	9	0	1	0	1	0	1	0	1	3
	3	0	1	0	1	0	0	0	0	5
	11	0	4	1	5	0	0	0	0[d]	-
	7	0	0	0	0[d]				-	-
	9	0	0	0	0[d]				-	-
Subtotal	39				7				1	8
Total	137				85				36	98

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. demissum	7	0	0	0	0	0	0	1	1	1
P.I. 160-221.2	3	0	1	0	1	0	0	0	0	4
	15	0	2	3	5	0	1	0	1	6
	6	1	3	0	4	1	2	0	3	14
	15	0	1	0	1	1	0	3	4	3
	5	0	0	0	0	0	0	0	0	2
	9	3	0	3	6	0	1	2	3	6
	8	0	4	1	5	0	1	1	2	8
	10	0	3	0	3	0	0	0	0	8
	10	0	2	0	2	0	1	0	1	12
Subtotal	88				27				15	64
Mean	2.90				.89				.50	2.11
		Water								
	11	4	0	1	5	0	0	0	0	1
	15	0	1	6	7	0	0	0	0	4
	11	0	2	0	2	1	1	1	3	7
	11	0	0	2	2[d]				-	-
	8	0	2	1	3[d]				-	-
Subtotal	56				19				3	12
Total	144				46				18	76

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1: 1^a	2^b	3^c	Total	Reaction period 2: 1^a	2^b	3^c	Total	Recovery period
					Three percent sucrose solution					
S. demissum	8	0	4	0	4	0	1	5	6	4
P.I. 161-149.3	12	0	2	8	10	0	4	5	9	16
	5	0	0	0	0	0	2	0	2	6
	11	1	3	2	6	0	1	6	7	8
	1	4	0	0	4	0	0	0	0	7
	19	0	7	2	9	0	0	5	5	14
	14	1	9	0	10	0	0	12	12	10
	13	1	1	0	2	0	1	6	7	10
	7	0	0	0	0	0	0	0	0	6
	17	0	1	0	1	0	4	5	9	12
Subtotal	107				46				57	93
Mean	3.53				1.52				1.88	3.07
					Water					
	5	0	0	0	0	0	3	0	3[d]	-
	11	0	9	2	11	1	2	2	5	12
	7	0	1	0	1[d]				-	-
	10	0	0	0	0[d]				-	-
	2	0	0	0	0[d]				-	-
Subtotal	35				12				8	12
Total	142				58				65	105

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. pampasense	5	0	3	0	3	2	0	-	2	12
P.I. 275-274.10	13	1	0	0	1	0	0		0	11
	5	0	7	4	11	1	3	-	4	5
	17	3	0	0	3	0	0		0	13
	15	2	0	0	2	1	1	-	2	6
	9	0	8	3	11	4	2	-	6	11
	4	0	7	0	7	0	0		0	1
	12	0	0	0	0	4	0	-	4	13
	6	0	0	0	0	0	3	-	3	2
	2	0	4	0	4	1	2	-	3	9
Subtotal	88				42				24	83
Mean	2.90				1.39				.79	2.74
		Water								
	10	9	0	0	9	3	0	-	3	5
	17	1	0	3	4	0	0	-	0	12
	8	0	7	0	7	6	2	-	8	15
	13	0	8	0	8	1	0	-	1	0
	13	0	5	0	5[d]				-	-
Subtotal	61				33				12	32
Total	149				75				36	115

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. polytrichon	14	0	2	0	2	4	0	0	4	7
P.I. 184-768.1	2	0	0	0	0	0	5	0	5	8
	11	0	1	1	2	0	0	4	4	16
	5	0	1	2	3	1	1	0	2	9
	23	0	2	2	4	0	2	0	2	14
	1	0	3	0	3	3	0	0	3	8
	12	0	1	1	2	0	3	4	7	13
	12	0	0	0	0	0	5	1	6	6
	7	0	2	0	2	0	5	0	5	8
	17	0	2	0	2	0	0	2	2	12
Subtotal	104				20				40	101
Mean	3.43				.66				1.36	3.33
		Water								
	5	0	0	2	2	0	4	1	5	8
	4	0	1	2	3	0	0	4	4	11
	7	0	0	0	0	0	0	0	0	6
	12	0	0	0	0[d]				-	-
	5	0	0	0	0[d]				-	-
Subtotal	33				5				9	25
Total	137				25				51	126

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. capsicibaccatum P.I. 205-560.1	7	0	5	2	7	4	4	0	8	8
	10	0	5	2	7	0	1	7	8	7
	5	0	1	0	1	0	4	2	6	8
	12	0	0	1	1	1	0	5	6	5
	17	0	7	0	7	1	0	6	7[d]	-
	16	0	3	0	3	1	2	6	9	11
	4	0	3	0	3	0	0	3	3	0
	18	0	1	3	4[d]					-
	3	4	0	0	4[d]					-
	6	0	0	0	0[d]					-
Subtotal	98				37				47	39
Mean	3.23				1.22				2.21	2.14
		Water								
	8	0	1	0	1[d]				-	-
	9	0	0	0	0[d]				-	-
	6	5	0	1	6	0	1	0	1	8
	12	2	0	2	4	0	0	0	0[d]	-
	6	1	4	0	5	0	4	0	4	0
Subtotal	41				16				5	8
Total	139				53				52	47

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. polyadenium	11	0	0	0	0[d]				-	-
P.I. 275-237	10	0	0	0	0[d]				-	-
	5	0	0	0	0[d]				-	-
	10	0	0	0	0[d]				-	-
	13	0	0	0	0[d]				-	-
	11	0	0	0	0[d]				-	-
	12	0	0	0	0[d]				-	-
	12	0	0	0	0[d]				-	-
	10	0	0	0	0	0	0	0	0	6
	11	0	0	0	0	0	0	0	1	4
Subtotal	105				0				1	10
Mean	3.46				0				.16	1.65
		Water								
	9	0	0	0	0	0	0	0	0[d]	-
	9	0	0	0	0	0	0	0	1[d]	-
	5	0	0	0	0[d]				-	-
	11	0	2	0	2[d]				-	-
	8	0	0	0	0[d]				-	-
Subtotal	42				2				1	-
Total	147				2				2	10

Table 20 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
S. fendleri	10	0	4	11	15	0	5	0	5	11
P.I. 275-162	8	0	5	1	6	0	10	0	10	18
	15	2	4	4	10	0	6	9	15	15
	5	0	2	8	10	1	1	0	2	0
	13	0	4	4	8	2	8	0	10	12
	1	3	1	0	4	0	0	0	0[d]	-
	6	0	0	0	0	0	9	5	14	7
	11	0	4	3	7	0	7	0	7	9
	11	1	1	2	4	0	6	6	12	7
	7	0	3	1	4	0	6	0	6	8
Subtotal	87				68				81	87
Mean	2.87				2.24				2.67	3.19
		Water								
	5	0	0	0	0	0	0	1	1[d]	-
	13	0	6	1	7	0	0	0	0	2
	14	0	0	0	0	0	0	0	0	0
	16	0	3	0	3	1	1	0	2	3
	3	0	6	0	6[d]				-	-
Subtotal	51				16				3	5
Total	138				84				84	92

Table 21. Number of *E. fabae* eggs laid on excised tissues of *Phaseolus* species during three-day reaction periods and during standard preconditioning and recovery on excised *V. faba* stems

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
				Three percent sucrose solution						
V. faba	15	-	-	10	10	-	-	8	8	12
Control-g	10	-	-	13	13	-	-	15	15	13
	20	-	-	18	18	-	-	12	12	16
	3	-	-	9	9	-	-	15	15	10
	12	-	-	10	10	-	-	8	8	3
	9	-	-	13	13	-	-	9	9	2
	9	-	-	6	6	-	-	10	10	10
	14	-	-	7	7	-	-	6	6	7
	10	-	-	8	8	-	-	7	7	7
	8	-	-	15	15	-	-	7	7	8
Subtotal	110				109				97	88
Mean	3.63				3.60				3.20	2.90
				Water						
	15	-	-	11	11	-	-	12	12	8
	10	-	-	14	14	-	-	9	9	7
	2	-	-	6	6	-	-	5	5	5
	6	-	-	3	3	-	-	3	3	6
	13	-	-	15	15	-	-	1	1	8
Subtotal	46				49				30	34
Total	156				158				127	122

[a]Leaf or leaflet.

[b]Petiole or rachis.

[c]Stem.

Table 21 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
P. aureus P.I. 219-699	19	7	0	-	7	0	5	-	5	10
	10	0	0	-	0	0	0	-	0	16
	6	0	7	-	7	2	2	-	4	8
	8	3	8	-	11	4	3	-	7	12
	7	7	0	-	7	2	6	-	8	10
	6	0	7	-	7	0	3	-	3	15
	13	7	0	-	7	7	0	-	7	5
	6	6	0	-	6	0	2	-	2	5
	8	0	5	-	5	5	0	-	5	7
	14	9	4	-	13	4	5	-	9	15
Subtotal	97				70				50	103
Mean	3.20				2.31				1.65	3.40
		Water								
	11	3	3	-	6	2	2	-	4	3
	8	0	6	-	6	2	1	-	3	8
	10	5	0	-	5	0	5	-	5	0
	9	0	5	-	5	0	0	-	0	5
	16	4	4	-	8	3	3	-	6	12
Subtotal	54				30				18	28
Total	151				100				68	131

Table 21 (Continued).

Species and accession	Pretest period	Reaction period 1: 1[a]	2[b]	3[c]	Total	Reaction period 2: 1[a]	2[b]	3[c]	Total	Recovery period
	Three percent sucrose solution									
P. aureus	3	6	0	-	6	5	1	-	6	2
P.I. 217-959	5	0	0	-	0	3	2	-	5	8
	14	2	4	-	6	4	0	-	4	8
	10	5	0	-	5	13	0	-	13	16
	16	10	6	-	16	7	10	-	17	16
	20	8	0	-	8	13	0	-	13	8
	6	3	7	-	10	14	0	-	14	7
	13	12	4	-	16	17	7	-	24	14
	17	15	3	-	18	10	0	-	10	18
	8	16	0	-	16	8	2	-	10	16
Subtotal	112				101				116	113
Mean	3.70				3.33				3.83	3.73
	Water									
	14	3	4	-	7	2	0	-	2	0
	8	12	2	-	14	4	2	-	6	12
	17	7	9	-	16	9	0	-	9	10
	6	9	0	-	9	6	6	-	12	16
	3	1	0	-	1	5	2	-	7	2
Subtotal	48				47				36	40
Total	160				148				152	153

Table 21 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
P. lunatus	12	5	0	-	5	1	0	-	1	5
P.I. 194-314	12	0	1	-	1	7	0	-	7	10
	7	0	0	-	0	3	0	-	3	7
	15	4	1	-	5	3	0	-	3	7
	9	0	0	-	0	4	1	-	5	11
	10	0	0	-	0	5	0	-	5	7
	7	0	0	-	0	0	0	-	0	5
	3	0	0	-	0	0	0	-	0	2
	6	4	0	-	4	1	0	-	1	0
	20	7	0	-	7	0	0	-	0	16
Subtotal	101				22				25	70
Mean	3.33				.73				.82	2.31
		Water								
	13	0	0	-	0	3	0	-	3	8
	4	1	1	-	2	0	0	-	0	2
	12	0	3	-	3	1	0	-	1	15
	14	1	3	-	4	1	1	-	2	11
	7	5	0	-	5	0	0	-	0	0
Subtotal	50				14				6	36
Total	151				36				31	106

Table 21 (Continued).

Species and accession	Pretest period	Reaction period 1: 1[a]	2[b]	3[c]	Total	Reaction period 2: 1[a]	2[b]	3[c]	Total	Recovery period
					Three percent sucrose solution					
P. vulgaris	9	2	0	-	2	5	0	-	5[d]	-
P.I. 169-718	15	1	0	-	1	0	0	-	0	14
	8	1	0	-	1	2	0	-	2[d]	-
	13	6	0	-	6	0	0	-	0	18
	12	9	2	-	11	4	1	-	5	22
	10	1	7	-	8	12	0	-	12	24
	14	3	6	-	9	0	0	-	0	12
	4	1	0	-	1	0	0	-	0	8
	6	5	1	-	6	10	0	-	10	12
	1	4	0	-	4	5	0	-	5	9
Subtotal	92				49				39	119
Mean	3.04				1.62				1.29	4.91
					Water					
	8	1	0	-	1	0	5	-	5	13
	13	10	3	-	13	0	0	-	0[d]	-
	13	10	0	-	10[d]				-	-
	16	5	5	-	10[d]				-	-
	6	5	3	-	8	0	0	-	0	6
Subtotal	56				42				5	19
Total	148				91				44	138

Table 21 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
P. vulgaris	16	5	1	-	6	2	0	-	2	0
P.I. 151-014	10	1	2	-	3	0	0	-	0	17
	10	7	2	-	9	5	0	-	5	9
	11	7	0	-	7	7	1	-	8	11
	10	1	5	-	6	0	0	-	0[d]	-
	12	11	0	-	11	7	0	-	7	9
	10	0	0	-	0	4	0	-	4	15
	11	2	2	-	4	0	0	-	0[d]	-
	11	0	0	-	0[d]				-	-
	8	5	9	-	14	4	0	-	4	14
Subtotal	109				60				30	75
Mean	3.60				1.98				1.10	3.54
		Water								
	15	3	8	-	11	0	0	-	0[d]	-
	10	3	0	-	3	0	0	-	0[d]	-
	5	1	0	-	1	1	0	-	1	12
	2	0	0	-	0	2	0	-	2	3
	12	10	0	-	10	0	0	-	0[d]	-
Subtotal	44				25				3	15
Total	153				85				33	90

Table 21 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1^a	2^b	3^c	Total	1^a	2^b	3^c	Total	
					Three percent sucrose solution					
P. vulgaris	9	5	0	-	5	5	5	-	10	9
P.I. 206-975	6	0	12	-	12	10	0	-	10	3
	17	11	1	-	12	8	2	-	10	15
	9	6	5	-	11	12	0	-	12	19
	8	8	2	-	10	8	8	-	16	16
	2	3	0	-	3	1	0	-	1	1
	7	2	10	-	12	13	0	-	13	12
	17	14	1	-	15	0	10	-	10	20
	12	3	10	-	13	5	3	-	8	22
	4	3	2	-	5	3	7	-	10	4
Subtotal	91				98				100	121
Mean	3.00				3.23				3.30	3.99
					Water					
	17	0	9	-	9	7	1	-	8	9
	13	3	3	-	6	0	0	-	0	9
	8	5	1	-	6	1	0	-	1	9
	3	0	14	-	14	0	8	-	8	2
	16	1	6	-	7	4	4	-	8	8
Subtotal	57				42				25	37
Total	148				140				125	158

Table 21 (Continued).

Species and accession	Pretest period	Reaction period 1: 1[a]	2[b]	3[c]	Total	Reaction period 2: 1[a]	2[b]	3[c]	Total	Recovery period
					Three percent sucrose solution					
P. vulgaris	11	2	0	-	2	2	0	-	2	9
P.I. 136-741	9	6	0	-	6	0	0	-	0	9
	8	0	0	-	0	0	0	-	0	14
	5	1	0	-	1	2	0	-	2	1
	6	0	0	-	0	6	0	-	6	14
	10	3	0	-	3	5	2	-	7	15
	7	0	0	-	0	3	0	-	3	16
	10	0	0	-	0[d]				-	-
	10	0	0	-	0	0	3	-	3	15
	17	0	0	-	0	5	1	-	6	0
Subtotal	93				12				29	93
Mean	3.07				.40				1.06	3.41
					Water					
	8	8	3		11	2	2		4	8
	13				0[d]				-	-
	9	1			1	4			4	2
	10	9			9	4			4	13
	14		8		8[d]				-	-
Subtotal	54				29				12	23
Total	147				41				41	116

Table 21 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
P. vulgaris	9	3	0	-	3[d]				-	-
P.I. 169-733	9	6	6	-	12	13	0	-	13	12
	7	7	0	-	7	5	0	-	5	6
	10	0	12	-	12	1	0	-	1	15
	14	3	0	-	3	7	0	-	7	15
	7	5	5	-	10	1	0	-	1	16
	10	5	3	-	8	7	0	-	7	10
	18	7	8	-	15	10	2	-	12	7
	6	7	4	-	11	0	0	-	0	7
	2	8	0	-	8	1	1	-	2	9
Subtotal	92				89				48	97
Mean	3.04				2.94				1.76	3.56
		Water								
	11	1	6	-	7[d]				-	-
	13	0	3	-	3[d]				-	-
	11	1	5	-	6	8	6	-	14	12
	20	12	6	-	18	1	0	-	1[d]	-
	9	5	4	-	9	0	0	-	0[d]	-
Subtotal	64				43				15	12
Total	156				132				63	109

Table 21 (Continued).

Species and accession	Pretest period	Reaction period 1: 1[a]	2[b]	3[c]	Total	Reaction period 2: 1[a]	2[b]	3[c]	Total	Recovery period
				Three percent sucrose solution						
V. faba Control-h	14	-	-	1	1[d]			-	-	-
	10	-	-	11	11	-	-	17	17	16
	14	-	-	10	10	-	-	12	12	12
	12	-	-	12	12	-	-	7	7	10
	10	-	-	12	12	-	-	8	8	8
	10	-	-	12	12	-	-	8	8	14
	13	-	-	13	13	-	-	9	9	10
	7	-	-	11	11	-	-	12	12	8
	5	-	-	10	10	-	-	12	12	7
	12	-	-	12	12	-	-	13	13	11
Subtotal	107				104				98	96
Mean	3.53				3.43				3.59	3.52
				Water						
	17	-	-	18	18	-	-	14	14	16
	17	-	-	9	9	-	-	10	10	0
	11	-	-	6	6	-	-	6	6	6
	13	-	-	10	10	-	-	4	4	2
	16	-	-	13	13	-	-	13	13	15
Subtotal	74				56				47	39
Total	181				160				145	135

Table 21 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
					Three percent sucrose solution					
P. aureus P.I. 207-504	16	6	0	-	6	3	0	-	3	4
	15	0	3	-	3	7	0	-	7	10
	16	1	2	-	3	1	3	-	4	11
	14	1	1	-	2	0	3	-	3	6
	11	0	5	-	5	6	1	-	7	10
	9	10	0	-	10	5	0	-	5	10
	12	11	0	-	11	9	1	-	10	16
	6	8	0	-	8	4	1	-	5	3
	4	1	0	-	1[d]				-	-
	16	6	2	-	8	2	6	-	8	9
Subtotal	119				57				52	79
Mean	3.93				1.88				1.91	2.90
					Water					
	17	2	0	-	2	0	0	-	0[d]	-
	4	2	0	-	2	0	0	-	0	5
	9	10	0	-	10	1	0	-	1	2
	14	6	0	-	6	0	0	-	0[d]	-
	4	0	4	-	4	1	0	-	1	0
Subtotal	48				24				2	7
Total	167				81				54	86

Table 21 (Continued).

Species and accession	Pretest period	Reaction period 1: 1[a]	2[b]	3[c]	Total	Reaction period 2: 1[a]	2[b]	3[c]	Total	Recovery period
					Three percent sucrose solution					
P. aureus	11	5	7	-	12	9	0	-	9	7
P.I. 164-889	11	6	0	-	6	5	4	-	9	14
	12	8	2	-	10	4	4	-	8	11
	10	6	1	-	7	8	3	-	11	14
	8	8	0	-	8	8	0	-	8	12
	7	6	0	-	6	0	5	-	5	11
	11	13	0	-	13	0	9	-	9	4
	10	1	4	-	5	0	2	-	2	0
	12	4	5	-	9	0	5	-	5	14
	9	4	2	-	6	0	5	-	5	3
Subtotal	101				82				71	90
Mean	3.33				2.71				2.34	2.97
					Water					
	17	6	1	-	7	0	0	-	0[d]	-
	6	8	2	-	10	0	3	-	3[d]	-
	14	2	5	-	7	0	4	-	4	3
	16	6	1	-	7	0	2	-	2	1
	7	1	8	-	9	0	5	-	5	6
Subtotal	60				40				14	10
Total	161				122				85	100

Table 21 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
P. lunatus	14	1	1	-	2	0	0	-	0	1
P.I. 195-340	5	2	5	-	7	0	0	-	0	4
	12	1	4	-	5	0	0	-	0	8
	10	0	6	-	6	2	0	-	2	5
	15	6	0	-	6	1	2	-	3	5
	19	16	4	-	20	0	0	-	0	8
	14	2	0	-	2	1	0	-	1	2
	15	2	8	-	10	0	2	-	2	8
	13	0	4	-	4	1	3	-	4	4
	13	0	0	-	6	0	0	-	0	6
Subtotal	130				68				12	51
Mean	4.29				2.24				.40	1.68
		Water								
	13	2	2	-	4	0	0	-	0	7
	16	3	2	-	5	0	0	-	0[d]	-
	4	1	8	-	9	0	0	-	0[d]	-
	1	1	2	-	3	0	0	-	0	0
	9	3	0	-	3	0	2	-	2	4
Subtotal	43				24				2	11
Total	173				92				14	62

Table 21 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1^a	2^b	3^c	Total	1^a	2^b	3^c	Total	
		Three percent sucrose solution								
P. lunatus P.I. 209-051	10	1	6	-	7	1	3	-	4	7
	6	2	1	-	3	2	1	-	3	2
	8	1	5	-	6	1	3	-	4	10
	10	2	7	-	9	2	7	-	9	6
	2	0	1	-	1	0	0	-	0	0
	12	5	2	-	7	2	1	-	3	6
	16	5	3	-	8	0	1	-	1	0
	16	5	5	-	10	1	5	-	6	8
	7	7	0	-	7	0	7	-	7	13
	12	1	8	-	9	13	0	-	13	11
Subtotal	99				67				50	63
Mean	3.27				2.21				1.65	2.08
		Water								
	7	4	3	-	7	9	1	-	10	6
	18	0	7	-	7^d				-	-
	10	8	0	-	8	5	4	-	9	10
	14	4	2	-	6	2	1	-	3	3
	17	5	2	-	7	0	2	-	2	5
Subtotal	66				35				24	24
Total	165				102				74	87

Table 21 (Continued).

Species and accession	Pretest period	Reaction period 1				Reaction period 2				Recovery period
		1[a]	2[b]	3[c]	Total	1[a]	2[b]	3[c]	Total	
		Three percent sucrose solution								
P. vulgaris P.I. 174-901	10	1	0	-	1	0	0		0	8
	9	2	0	-	2	1	3		4	7
	15	5	2	-	7	0	0		0	20
	15	0	0	-	0	2	0		2	1
	3	0	0	-	0	1	0		1	6
	10	1	1	-	2	2	0		2	8
	16	9	0	-	9	0	0		0	7
	11	4	0	-	4	4	0		4	2
	9	0	0	-	0	0	0		0	2
	9	2	0	-	2[d]				-	-
Subtotal	107				27				13	61
Mean	3.53				.89				.48	2.24
		Water								
	9	2	0	-	2	4	2	-	6	8
	18	8	1	-	9	5	7	-	12	0
	9	2	5	-	7	6	0	-	6	12
	15	0	0	-	0	0	0	-	0[d]	-
	6	0	4	-	4	5	0	-	5[d]	-
Subtotal	57				22				29	20
Total	164				49				42	81

Table 21 (Continued).

Species and accession	Pretest period	Reaction period 1: 1[a]	2[b]	3[c]	Total	Reaction period 2: 1[a]	2[b]	3[c]	Total	Recovery period
					Three percent sucrose solution					
P. vulgaris P.I. 209-467	13	4	6	-	10	18	3	-	21	15
	11	3	14	-	17	2	5	-	7	11
	12	6	1	-	7	1	0	-	1	8
	7	15	0	-	15	10	4	-	14	14
	9	3	6	-	9	6	0	-	6	13
	17	3	1	-	4	3	1	-	4	8
	15	13	0	-	13	8	4	-	12	13
	18	15	0	-	15	3	3	-	6	10
	2	0	0	-	0	0	0	-	0	0
	6	1	0		1[d]				-	-
Subtotal	110				91				71	92
Mean	3.63				3.00				2.60	3.37
					Water					
	10	3	2	-	5	0	0	-	0	4
	5	3	1	-	4	4	0	-	4	5
	11	14	0	-	14	13	0	-	13	7
	16	1	6	-	7	3	4	-	7	9
	8	5	0	-	5	0	3	-	3	1
Subtotal	50				35				27	26
Total	160				126				98	118

Table 22. Number of *E. fabae* eggs laid on excised *V. faba* and *S. chacoense* stems during three-day reaction periods and during standard preconditioning and recovery

	V. faba				*S. chacoense*			
	Pretest period	Reaction period 1	Reaction period 2	Recovery period	Pretest period	Reaction period 1	Reaction period 2	Recovery period
	Water without an agar plate							
	12	8	0[d]	-	11	0	0	1
	12	6	0	0	14	0[d]	-	-
	16	3	0	0	16	0	2[d]	-
	16	9	1	5	18	2[d]	-	-
	9	8	0[d]	-	6	0[d]	-	-
	10	9	3	0	12	0[d]	-	-
	13	9	12	11	13	0[d]	-	-
	11	5	0[d]	-	13	0[d]	-	-
	17	11	12	18	14	2	0[d]	-
	4	0	1	0	13	1	0	0[d]
Total	120	68	29	34	130	5	2	1
Mean	3.00	2.24	.96	1.60	3.25	.16	.16	.16
	Three percent sucrose solution without an agar plate							
	14	10	11	14	5	0	0	2
	12	9	4	3	10	0	0	7
	10	2	1[d]	-	13	0	4	7
	10	10	9	4	13	3	0	3
	11	3	12	14	18	0	0	9
	14	9	11	14	6	0	0	0[d]
	14	8	11	15	16	0	0	13
	7	4	3	0	12	0	0	3
	14	14	11	8	15	0	3	7
	20	12	15	16	8	0	0	8
Total	126	81	88	88	116	3	7	59
Mean	3.15	2.67	2.90	3.23	2.90	.10	.23	1.95

Table 22 (Continued).

	V. faba				*S. chacoense*			
	Pretest period	Reaction period		Recovery period	Pretest period	Reaction period		Recovery period
		1	2			1	2	
				Water with an agar plate				
	13	6	6	6	8	0	0	3[d]
	14	7	6	5	12	0	0	3[d]
	10	8	6	10	21	0	2	10
	16	9	4	12	10	0	0	3
	6	7	2	7	9	0	0	5
	14	5	11	10	19	0	2	8
	16	9	3	5	14	0	0	9
	12	8	4	2	8	2	0	0[d]
	11	3	6	10	12	0	0	1[d]
	4	2	8	7	13	0	0	1
Total	116	64	56	74	126	2	4	43
Mean	2.90	2.11	1.85	2.44	3.15	.07	.13	1.42
				Three percent sucrose solution with an agar plate				
	8	3	16	15	11	0	1	8
	10	5	9	8	13	0	0	4
	10	9	10	11	12	0	4	11
	16	14	13	4	12	0	0	7
	16	15	9	12	15	0	2	7
	13	8	10	6	8	0	0	6
	21	14	12	10	15	0	0	11
	10	6	5	12	13	0	0	5
	13	0	8	0	6	0	0	9
	12	4	0	0	15	0	0	7
Total	129	78	92	78	120	0	7	75
Mean	3.22	2.57	3.04	2.57	3.00	0	.23	2.48